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Addressing the rural in situ urbanization (RISU) in the Beijing–Tianjin–Hebei region: Spatio-temporal pattern and driving mechanism

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ABSTRACT

Rural in situ urbanization (RISU) indicates that rural settlements transfer into urban land within the original rural settlements area from the perspective of land use. A quantitative study from the perspective of land use can reveal trends of RISU and provide a basis for the promotion of the healthy and rational development of urbanization. Based on the investigation data of land use change of Beijing-Tianjin-Hebei in the period from 2003 through 2015, this paper analyses the spatio-temporal pattern of RISU through the elaboration of RISU and the construction of a rural in situ urbanization index (RISUI), and the driving mechanism of RISU is subsequently discussed. The results showed that RISU fluctuated during the study period in Beijing-Tianjin-Hebei, and its scale between different levels shifted from polarization to balance. RISU displayed a significant spatial agglomeration with the combined influence of siphon and spillover effects in Beijing and Tianjin, and its spatial scope expanded to the periphery with Beijing as the centre. The findings further revealed that RISU was developed under the comprehensive influence of population, economy, social public service and space. To realize the healthy and benign development of urbanization, the government should vigorously promote the RISU of small towns on the basis of resource environmental bearing capacity and the land construction foundation. Meanwhile, urban-rural construction land and the allocation of public service resources should also be arranged.

1. Introduction

Since the 1990s, urbanization, as the most significant power to influence global landscape dynamics (Deng, Wang, Hong, & Qi, 2009), has become a worldwide socioeconomic phenomenon and an important scientific research field (Jiang, Ma, Qu, Zhang, & Zhou, 2016; Lu, 2007). It aroused fundamental changes in the socioeconomic structure and mode of life (Hersperger, Franscini, & Kübler, 2014), as well as the dynamic change of space entities such as urban space propulsion (Antrop, 2004; Chen, 2008; Hersperger et al., 2014; Lv, Zhou, Zhang, & Tian, 2008; Shen, Zhu, & Lei, 2015). There are multidimensional concepts for urbanization, i.e., population urbanization, economic urbanization, social urbanization and land urbanization (Deng, Huang, Rozelle, & Uchida, 2008; Li, Liao, Wang, & Shi, 2015). Among of these, the essence of land urbanization is a transformation of land use function, and the implementation of industrial restructuring, population migration and infrastructure construction all require the reconfiguration of land use (Shen et al., 2015).

There are many paths of land urbanization, the dominant of which is "aggressive" expansionary urbanization (Hersperger et al., 2014), which is caused by the migration of rural labour to large cities (Xing & Zhang, 2017; Yu, Yong, & Choi, 2017) and belongs to the category of migration urbanization (Liu, Li, & Peng, 2015; Siciliano, 2012). Although this path promotes the economic development of a city rapidly (Chen, 2015; Fan & Liu, 2014), it also produces a lot of negative effects such as the disorder urban land sprawl (Wang, Mao, Li, & Jia, 2013; Xiao et al., 2006) and extensive land-use pattern (Brueckner & Largey, 2006; Jiang, Ma, Zhou, Zhao, & Zhang, 2017). The urban land sprawl has occupied a variety of land use types, such as cultivated land, forest land and swamp, thereby threatening the regional food and ecological security (Deng, Huang, Rozelle, Zhang, & Li, 2015; López, Aide, & Thomlinson, 2001; Pribadi & Pauleit, 2015; Jiang, Zhang, et al., 2017). Consequently, this path can be

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characterized as a kind of unhealthy urbanization (Zhu, 2000a), and its constant implementation will result in the excessive consumption of resources and the increase in environmental costs and even destroy the urban sustainable development (Chen, 2007; Deng et al., 2015; Fan & Liu, 2014; Jia & Yun, 2015; Wu & Anthony, 1999).

Some developed countries, such as Germany and American, have generally viewed rural in situ urbanization (RISU) as an important path to promote the development of urbanization. In contrast, due to poor economic foundations, most developing countries have shown little interest in this path (Jiao, 2015; López et al., 2001). Based on the original space of rural settlement areas, RISU mainly relies on central villages or small towns to realize the local land and population urbanization (Hu & Wen, 2015). The transformation of rural settlements to urban built-up land can effectively reduce the demand of urban land sprawl,deduce the excessive waste of ecological resources,and promote the optimal utilization of land resources (Jiang, He, Qu, Zhang, & Yuan, 2016; Ma, 2011). In addition, some serious problems such as “rural hollowing” and “city diseases” caused by urban land sprawl could also be effectively avoided (He et al., 2011; Sun, 2015). Currently, there is a large scale of rural settlements in China, but its land-use efficiency is extremely low, which provides a great potential for urbanization in rural areas. Therefore, RISU can be seen as an important tool for controlling the urban sprawl, and as a new form of urbanization, it can promote sustainable development of local resources and the environment (Guo & Zou, 2015; Hu & Wen, 2015; Jiang, Wang, Yun, & Zhang, 2015).

China is the largest developing country in the world, but its urbanization rate was only 56.1% in 2015 (Bureau C.S., 2016). Under the urban-rural dual structure (Xu, Shi, & Huang, 2014; Zhang, 2011), the economic structure, household registration system, infrastructure construction, and resource allocation between urban and rural areas are poorly coordinated (Lu, 2009; Wu, Chen, Gu, & Zhang, 1997). As a path of urbanization dominated by the government, RISU can promote the tilt of public finance towards rural areas and promote the level of rural infrastructure and public service to meet urban standards. It can also promote the transformation and upgrading of rural industries as well as the balanced allocation of urban and rural public resources (Guo & Zou, 2015; Hu & Wen, 2015; Huang, Yang, & Qian, 2015). Thus, RISU can contribute to breaking the urban-rural dual structure and promoting the coordinated development of urban and rural areas in China.

As the “Capital City Group” of China (Hu & Kaplan, 2001), Beijing-Tianjin-Hebei metropolitan area has a high urbanization rate as 62.51% (Bureau C.S., 2016). Its urbanization policies have played an important role in guiding the practice of urbanization in China. However, the population and industries of Beijing and Tianjin are over-concentrated in the process of urban development, which have leaded to some serious problems like city diseases (Ban, Gamba, Gong, & Du, 2013; Jia & Yun, 2015) and the disequilibrium between urban and rural areas (Wu, Zhao, Zhu, & Jiang, 2015; Yue, Zhong, Qing, & Bao, 2016). At present, under the policies of “easing of non-capital function” (Yu & Zang, 2015), “building a new socialist countryside” and “link between rural-urban built-up lands” (Ahlers & Gunter, 2013; Qu, Jiang, Zhang, & Zhao, 2013), the RISU in Beijing-Tianjin-Hebei has acquired a good basis of development, which can help to contribute to the “Beijing-Tianjin-Hebei regional integration” (Chang, 2014; Chen & Li, 2009) and solve above problems in cities. This situation of Beijing-Tianjin-Hebei is very typical and representative for conducting research of RISU, which has important academic significance and can provide a reference for the urbanization development in other areas of the world.

Current studies mainly focus on the urbanization of large cities (Brockerhoff, 1996; Murzin, 2014; Zhu, 2004), in particular the migration urbanization (Bhagat & Mohanty, 2009; Cerrutti & Bertoncello, 2003), but studies on RISU in medium-sized cities, small cities, towns and villages are seriously inadequate. This paper studies RISU from the perspective of land use, aiming to explore two questions: 1) What is the spatial pattern of RISU in Beijing-Tianjin-Hebei and its difference with the pattern of traditional urbanization? 2) What is the driving force of RISU and its difference with the driving force of traditional urbanization? Through this study, we try to enrich the research system of RISU and provide a theoretical reference and policy suggestions for the implementation of urbanization.

Therefore, this paper takes Beijing-Tianjin-Hebei as a case study and the investigation data of land use change of the period from 2003 through 2015 as the data basis. We attempt to construct a rural in situ urbanization index (RISUI) through the elaboration of the annotation of RISU and further analyse the spatio-temporal evolution of RISU. Finally, the driving mechanism of RISU is analysed in depth using the Geodetector method.

The rest of this paper is organized as follows. Section 2 provides a literature review and theoretical framework. Section 3 introduces the study area, data sources and research methods. Section 4 measures the spatio-temporal pattern of RISU and analyses its driving mechanism. Section 5 draws conclusions and discusses the phenomena involves in the process of urbanization and the potential theoretical contributions as well as suggests an appropriate urbanization direction.

2. Literature review and theoretical framework

2.1. Literature review

2.1.1. Urbanization

Urbanization is an international phenomenon (Njoh, 2003). It is generally believed that since the British Industrial Revolution, many countries in the world have begun to shift from a traditional agricultural-based rural society to a modern urban society based on industries and services (He, 2009). Urbanization is a natural historical process of the evolution of human society, which follows a common law but shows different characteristics at different times and in different countries (Zhai, 2015). Since the 1950s, urbanization has gradually become the focus of planning scholars and economic geographers. At present, the global urbanization and urban system are undergoing an important transformation and reconstruction, and the urbanization in developed countries has almost entered the mature stage, while the focus of urbanization has begun to shift to developing countries (Chen, 2015). In Asia and Latin America, some countries and regions have experienced excessive urbanization, and the unique path of China's urbanization road has, in particular, caused extensive concern in the international academic community (Chen, 2015).

Current studies of urbanization cover a wide range of topics and analyse the concept from multiple angles, including the connotation (Chan & Hu, 2003; Njoh, 2003; Osborne, 2005; Zhang, 2008), type and evolution process of urbanization (Cohen, 2006; Gu & Wu, 2010; Tisdale, 1942; Woods, 2003) as well as the spatio-temporal characteristics, driving mechanisms (Renaud, 1981; Wu, Jenerette, Buyantuyev, & Redman, 2011; Zhu, 2000a), and implementation paths of urbanization. With the blending and infiltration of different disciplines, the interdisciplinary research of urbanization gradually becomes prevalent, and urbanization research has gradually been combined with economic development (Chen, Zhang, Liu, & Zhang, 2014; Li & Cheng, 2005), social change (Goryakin, Rocco, & Suhrcke, 2017; Wang, Hui, & Sun, 2017), ecological environment (Peng, Shen, Wu, Liu, & Wang, 2016), soil and water resources (Feng, Chen, Hayat, Alsaedi, & Ahmad, 2015) and other fields, and further has become a new research hotspot.

To explore the regional differences and driving mechanism of urbanization and rationally control the development of urbanization, a large number of scholars have conducted studies of spatial patterns and driving factors of urbanization (Bhagat & Mohanty, 2009; Buyantuyev, Wu, & Gries, 2010; Renaud, 1981; Tatem & Hay, 2004; Wu et al., 2011). Scholars generally believe that the common characteristic of urbanization in different areas is that it mainly occurs in the urban hinterland and fringe, and the unbalanced polarization between urban and rural areas is obvious (Hasse & Lathrop, 2003; Ji, Ma, Twibell, & Underhill, 2006). Studies on the driving mechanism of urbanization mainly involve factors such as physical geography, population, industry, policy and society (Brueckner, 2000; Gu & Liu, 2013; Li, Wang, Zhu, & Zhao,

2014). Scholars believe that population and industry are the most important factors that drive the development of urbanization (Brueckner, 2000). Population is the core of urbanization, the migration and agglomeration of population are the decisive factors of urban sprawl, and the agglomeration of industries is the basis of urbanization (Cao, Zhang, Pan, & Zhang, 2012; Li, Liao, Yang, Zhuang, & Shi, 2015). All these studies can provide an important reference and contrast for the study of RISU.

2.1.2. Rural in situ urbanization

The academic community has conducted a wide range of discussions about how to achieve urbanization, among of them, migration urbanization and RISU have attracted more attention. Scholars generally believe that migration urbanization is mainly characterized by the large-scale cross-regional flow of population to achieve the transfer of the space of production and life where peasants migrate towards towns (Goodall, 2004; Lucas, 1998). At present, many developing countries, such as China, India and countries in Africa and Latin America, generally adopt this path of urbanization, which was common in developed countries such as the United States, Britain and Japan in the last century (Bhagat & Mohanty, 2009; Cerrutti & Bertoncello, 2003; Chen & Hao, 2005; Khan, 1982; Mears, 1997; Zhang & Song, 2003). Although the path can produce an obvious aggregation effect and significantly promote the development of urbanization, without effective regulation from the government, the phenomenon of excessive urbanization along with serious city diseases can easily worsen in the process of urbanization.

In contrast, some scholars advocate the path of RISU, which focuses on the development of small towns and is a process for peasants to achieve the non-agricultural employment and citizenization based on the space of their original village centers and small towns (He, 2009; Zhou & Wang, 2015; Zhu, 2004). Nevertheless, in view of the socio-economic comparative advantage and the cost of urbanization, planners have paid less attention to RISU, which has limited its development (Zhu, 2000b). In fact, RISU, as an important path and direction of new urbanization, can absorb a large number of surplus labour forces in rural areas, promote the development of societal and economic undertakings, and narrow the gap between urban and rural areas to effectively alleviate the problem of excessive urbanization (Cai, Zhang, & Wu, 2015; Guo & Zou, 2015). The rural urbanization in South Korea and the path of urbanization in German Bavaria are both examples of RISU (Chen, 2015).

The current research on RISU mainly involves its theory and concept (Huang et al., 2015; Zhao & Cui, 2013; Zhou & Wang, 2015; Zhu, 2005), the factors that influence peasants to choose that approach (Xu & Zhang, 2016; Zhao, 2016), and how it is realized (Cui & Zhao, 2013; Li, Zhang, & Chen, 2016; Xuan, 2016; Zeng, 2015). Some studies present in-depth discussions of the differences in the connotation and the advantages and disadvantages between migration urbanization and RISU (Hu & Li, 2014; Zhong, 2013). In addition, some scholars have conducted field investigations of towns to present the implementation experience of urbanization in practice (Getis & Ord, 1992; Hu, Liao, & Liu, 2014; Liu, 2014; Shao & Zhu, 2007; Zheng, 2014). However, studies on the spatial pattern and driving mechanism of RISU are relatively lacking. In addition, current studies mostly take population and industry as the research perspective; a quantitative study on RISU from the perspective of land is still lacking. The land is the spatial canvas of all the urban activities. Conducting studies on urbanization from the perspective of land use is an important combination of studies of rural land use and urbanization. It can reflect the spatial scope and direction of urban sprawl to provide a reference for the spatial development of urbanization.

2.2. Theoretical framework

Because studies on the spatial patterns and driving mechanisms of RISU are relatively lacking, this paper chooses Beijing-Tianjin-Hebei as a case area and conducts research on RISU from the perspective of land use. This paper mainly explores two questions: 1) What is the spatial pattern of RISU in Beijing-Tianjin-Hebei and its difference with the pattern of traditional urbanization? 2) What is the driving force of RISU and its difference with the driving force of traditional urbanization? The purpose is to explore whether the spatial pattern and driving mechanism of RISU is consistent with that of traditional urbanization. Therefore, to construct the theoretical framework of a study on RISU, this study takes urbanization as the point of penetration, introduces RISU with the connotation and the path of urbanization, and constructs the driving mechanism of RISU from four aspects: population, public service, economy and space. Urbanization is a comprehensive problem, which involves a range of connotations such as population urbanization, economic urbanization, societal urbanization and land urbanization (Cao et al., 2012; Li et al., 2015; Yang, Liu, & Long, 2015). Actually, population is the core of urbanization, and the essence of population urbanization is the transforming process from rural residents to urban residents, which can be expressed by the proportion of urban residents (Cao et al., 2012). Economic urbanization is the basis and guarantee of urbanization; it can be characterized by the degree of agglomeration, the rationality of structure and the sustainability of non-agricultural industrial elements within urban space (Li et al., 2015). Social urbanization refers to the improvement of the social welfare level in housing, education, medical care and social security after the citizenization of the non-agricultural population (Hu, 2014; Ye, 2001). Land is the carrier of spatial development of urbanization, and land urbanization refers to the transforming process from other land types towards urban built-up land in the process of urban spatial sprawl (Li et al., 2015; Yang et al., 2015). Viewed from the realization of urbanization, there are two paths path of urbanization: migration urbanization and RISU, and their difference mainly lies in whether there is a large-scale migration of population (Cerrutti & Bertoncello, 2003; Chan, 1994) (Fig. 1).

Conducting research on RISU from the perspective of land use can be seen as an important combination of the connotation of land urbanization and the path of RISU. RISU is a type of transformation process of land use from the perspective of land use, and various factors such as economy, population, public service and space can influence its development and produce changes (Li, Wen, & Lin, 2012; Zhang & Kong, 2014). The geographic space, as a bearer of cities, reflects the development of the urban space, and in particular, the urban land space is an important limiting factor that affects the development of cities. The foundation of geographic construction, such as urban built-up land and traffic land, mainly affects the scale, spatial sprawl direction and distribution of RISU (Alphan, 2003; Jenerette and Potere, 2010). Population urbanization is not only the intuitive performance of urbanization but also the core of urbanization, and human socio-economic activities play a major guiding role in RISU (Li et al., 2015). The migration and settling of population require the corresponding space to support them, so population plays an important role in guiding the spatial development of urban land. Meanwhile, as a major participant of economic activities, the labour force can significantly promote the development of the economy of urban areas (Li, 1997). The development of the economy, as the most fundamental reason for urbanization, is the basis for all social and economic activities; it supports and guarantees the development of RISU (Maruapula et al., 2011). The difference of economic level between urban and rural areas is the most important factor to influence the migration of population, and the economy mainly guides the development of urban land space through changing the direction of the migration of population. In addition, the improvement of the economic level can significantly improve the level of social public service such as education and medical care (Ran, Zhang, & Zhang, 2009). Social public service, the soft infrastructure of urbanization, is closely related to the lives of urban residents (Ran, 2013; Xue, Wu, Wang, & Lin, 2016). In fact, peasants who are the direct participants and beneficiaries of urbanization play an important role in the development of RISU (Xu & Zhang, 2016). Social public service mainly

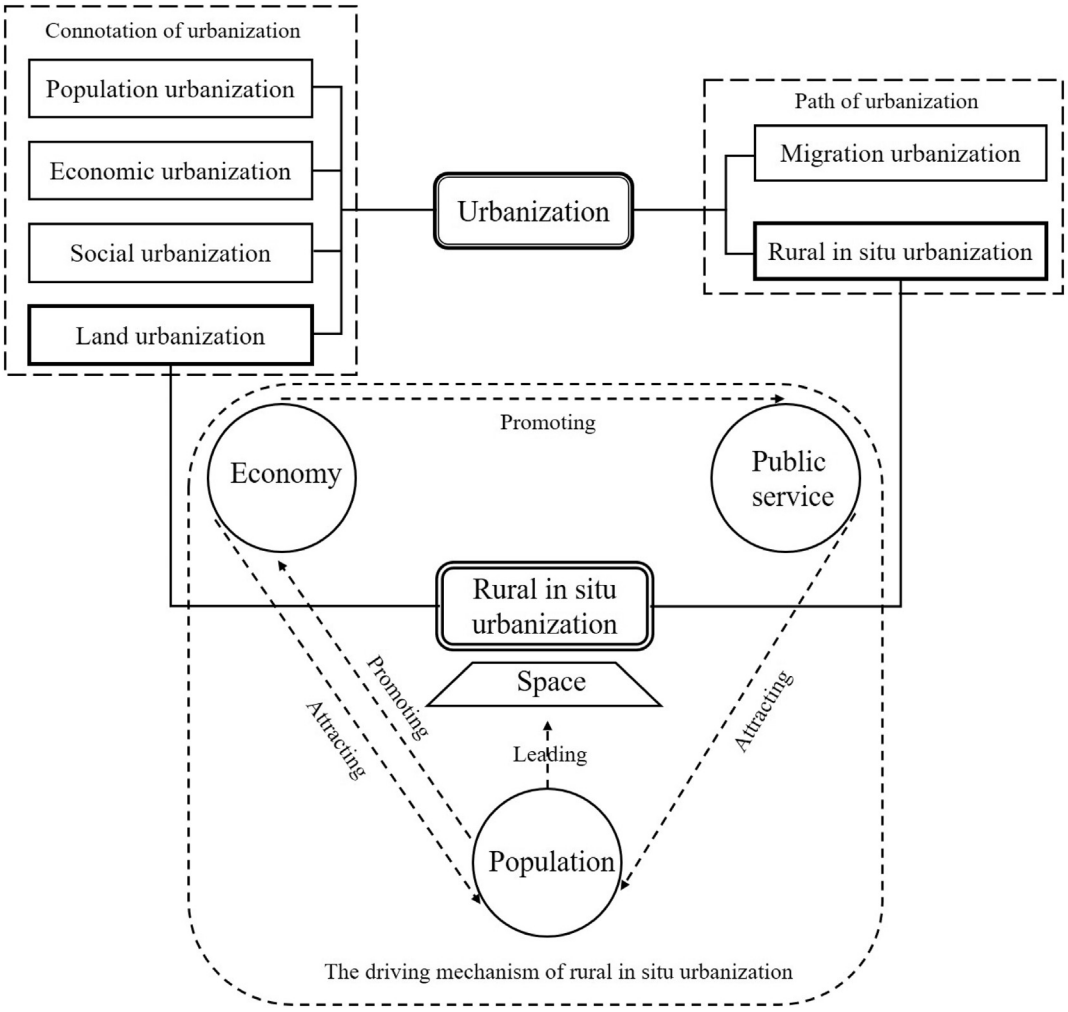


Fig. 1. The theoretical framework for understanding RISU.

guides the development of urban land space by attracting the population.

3. Methodology and data

3.1. Study area

The Beijing-Tianjin-Hebei region is the centre of the Bohai Economic Rim and the third major economic growth hub in China. This region includes Beijing and Tianjin, two municipalities directly under the central government, and 11 prefecture-level cities, such as Baoding, Shijiazhuang, Zhangjiakou, Tangshan, Langfang, Qinhuangdao, Chengde, Cangzhou, Handan, Xingtai, and Hengshui in Hebei province. The terrain of Beijing-Tianjin-Hebei is complex and varied, with the Yanshan mountain range to the north and the Taihang mountain range occupying the west from north to south. The terrain characteristics of Beijing-Tianjin-Hebei are high in the northwest and low in the southeast, and the mountainous area covers a total of 61 counties (Fig. 2).

Since the beginning of the new century, urban built-up land in Beijing-Tianjin-Hebei has continued to expand; the scale of rural settlements has not decreased. The area of urban and rural land was 2,435,000 ha in 2015; however, rural settlements accounted for as much as 60.82%. In the future, the urban and rural land use dynamic in Beijing-Tianjin-Hebei will dramatically change to form a world-class city metropolitan area, with the capital Beijing as the core. However, as a result of land resource and environmental bearing capacity, future urbanization in Beijing-Tianjin-Hebei should emphasize the implementation of RISU and gradually transform the traditional "aggressive" development mode towards a new healthy development path of urbanization.

3.2. Data sources

The land use classification system adopted in this study is the China's National Standard Current Land Use Classification (GB/T 21010-2007) (Wang, Yang, Lee, Ji, & You, 2016; Wen & Wu, 2010). It classifies all land in China and gives every land type a definitive connotation. Under the classification, urban built-up land is defined as the settlement of city and town, including many types of land such as commercial, residential, industrial, storage, school, transportation and green land. Rural settlements also include many types of land such as commercial, residential, industrial, storage, school, transportation and green land (Chen & Zhou, 2007; Hu, 2013).

The land use data and changes are mainly drawn from the investigation data of land use change in Beijing-Tianjin-Hebei from 2003 to 2015. The relevant economic indicators are mainly derived from the statistical yearbooks of Beijing, Tianjin and Hebei. All land and economic data are provided by the Bureau of Land and Resources in Beijing, Tianjin and Hebei.

According to the Chinese current land use classification, based on the digital orthophoto map, the acquisition of the investigation data of land use change is conducted by the Bureau of Land and Resources (Wang et al., 2015; Wu, Fan, Li, & Kuang, 2013). Its scale is 1:10,000. The purpose of the investigation of land change is to acquire the change of

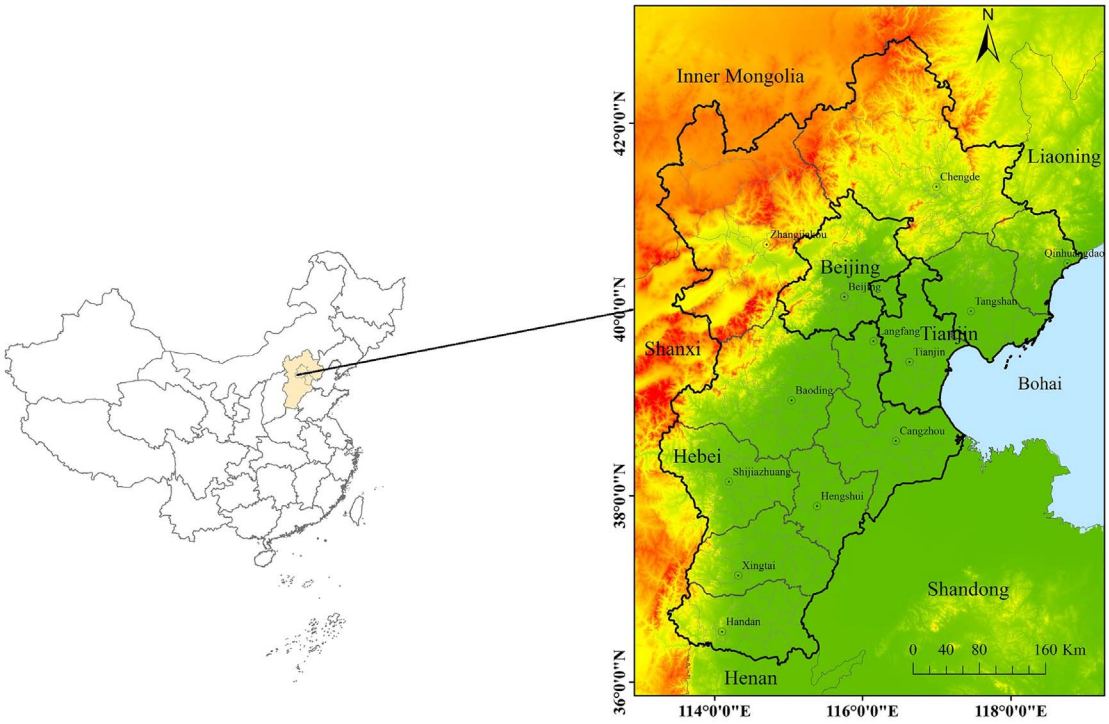


Fig. 2. The geographical location of Beijing-Tianjin-Hebei.

the status of land use, land ownership, and other land management information during the year and then update the land investigation database and summarize all information of land change (Guo & Li, 2009).

This study took the county-level administrative units as the basic research units, based on the administrative divisions in 2015, and merged the research units that had been adjusted for the administrative divisions during the period from 2003 to 2015. Eventually, 173 research units were obtained. There only exists the merger of administrative units, so the statistical yearbook data of the merger are obtained through the summation and other computation of the statistical yearbook data of the original administrative units according to the unit of data.

3.3. Research methods

First, this paper expounds upon the meaning of RISU, and a RISUI for the purpose of the study is subsequently presented. We studied the temporal evolutionary characteristics of RISU in the Beijing-Tianjin-Hebei region and county, and we performed our spatial pattern characteristic analysis using the spatial autocorrelation method. We discussed the driving mechanism of RISU from the perspective of population, economy, social public service and space. The study provides a scientific theoretical basis for the healthy and rational development of urbanization in Beijing-Tianjin-Hebei.

3.3.1. Rural in situ urbanization index

RISU has different meanings from different perspectives. In terms of land use, RISU represents a transformation process of land use type. It indicates that rural settlements transfer into urban built-up land within the original rural settlements area as the spatial basis for construction. A land transfer matrix can provide abundant information about the structure and the direction of land use type transformation of a region. This study analysed the transfer source of urban built-up land in Beijing-Tianjin-Hebei using a land transfer matrix, and we used the area of rural settlements that were transferred into urban built-up land to represent the scale of RISU. Based on the above, we constructed the RISUI to indicate the level of the development of RISU in the study area.

$$\mathrm{RISUI} = \frac{S}{S + S_1 + \ldots + S_n} \tag{1}$$

Formula (1) shows how to calculate the RISUI. S is the area of rural settlements that transferred into urban built-up land, and S_n is the area of the n-th land use type that transferred into urban built-up land. The value of RISUI is 0–1; the larger the value, the higher the level of RISU. When the value of RISUI is 1, all urban built-up land is derived from rural settlements in the study area during the study period. However, if the value of RISUI is 0, the source of urban built-up land excludes rural settlements.

3.3.2. Spatial autocorrelation

In this paper, the spatial autocorrelation method is used to analyse the spatial pattern of urbanization in the rural areas of Beijing-Tianjin-Hebei, and the spatial weight matrix is established based on the common side or common point of each study unit with the Queen contiguity adjacency standard. Spatial autocorrelation, which includes global autocorrelation and local autocorrelation, can measure the degree of interdependence between attributes at a location and attributes at other locations. The measure of spatial autocorrelation is implemented by OpenGeoDa1.2.0. First, we used the global spatial autocorrelation statistics—Global Moran's I—to describe the overall distribution of RISU and determine whether the distribution of RISU had spatial agglomeration (Anselin, 1995).

Global Moran's I formula is as shown in formula (2).

$$I = \frac{n\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij} \times \sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{2}$$

where n is the number of research units indexed by i and j; x is the variable of interest; $\bar{x}$ is the mean of x; x_i, x_j are the scale of RISU in the research unit i, j; and w_{ij} is an element of the binary spatial weight matrix, which is created through the Queen contiguity adjacency standard based on the common edges or the common point of the research units; the value of I ranges from -1 to 1. When the value of I is positive, the observed value of these research units appears as a spatial positive correlation; when I is negative, the observation value of these

research units appears as a spatial negative correlation; I is 0 indicates that the observed value does not have spatial autocorrelation. A higher absolute value of I denotes a stronger degree of spatial autocorrelation. The normalized statistic Z can be used to characterize the significance of spatial autocorrelation (Jiang, He, Ma, Wang, & Zhang, 2015). The formula is as shown in formula (3).

$$Z = \frac{I - E(I)}{\sqrt{VAR(I)}} \tag{3}$$

where *E(I)* is the expected value of *I*, and *VAR(I)* is the variance of *I*. Under the confidence level of 0.05, $|Z| = 1.96$, and if $|Z| > 1.96$, then the spatial autocorrelation in this region is significant; under the confidence level of 0.01, $|Z| = 2.58$, if $|Z| > 2.58$, then the spatial autocorrelation in the region is significant.

We further explored the spatial location of the agglomeration centre by using the local spatial autocorrelation method, and we used the agglomeration map of local indicators of spatial association (LISA) to reveal the main agglomeration units of RISU. Based on the results of the significance test, all the research units can be divided into high–high agglomeration, low–low aggregation, high–low aggregation, low–high aggregation and no significant agglomeration—five types according to different types of agglomeration degree High–high agglomeration means the region is the centre of high value and is surrounded by high-value areas. Low–low aggregation means the region is the centre of low value and is surrounded by low-value areas. High–low aggregation means the region is the centre of high value and is surrounded by low-value areas. Low–high aggregation means the region is the centre of low value and is surrounded by high-value areas. No significant agglomeration means the agglomeration in these areas is not significant (Epperson & Li, 1996; Jiang, He, et al., 2015).

3.3.3. Geographical detector

3.3.3.1. Calculation formula. A geographic detector is a group of statistical methods, which were developed by the Wang Jinfeng space analysis team at the Institute of Geographic Sciences and Resources, Chinese Academy of Sciences (Wang, Xi, Yang, & Chen, 2012). This method can be used to detect the spatial variability of objects in geographic space and reveal the driving factors that cause this spatial variation and the interaction between any two factors. The geographic detector can be implemented by GeoDetector Software, which is available at http://www.geodetector.org/ (Wang & Xu, 2017). This study investigated the influencing factors of RISU in the Beijing-Tianjin-Hebei region using the geographical detector method. The influence degree of each factor on the RISU can be measured by $P_{D,H}$. The formula is as follows.

$$P_{D,H} = 1 - \frac{1}{n\sigma^2}\sum_{h=1}^{L} n_h \sigma_h{}^2 \tag{4}$$

where $P_{D,H}$ is the explanatory force of the influence factor D on RISU H; n and σ^2 are the sample size and variance; and n_h and σ_h^2 are the sample size and variance of the h (h = 1,2, …, L) layer. The value of $P_{D,H}$ ranges from 0 to 1; the larger the value, the stronger the explanatory power of the influencing factors to RISU; otherwise, the weaker. The value of 0 shows that the influence factor has nothing to do with the RISU, while the value of 1 indicates that the influence factor has complete control over the spatial distribution of the RISU.

The geographic detector contains four parts, which are risk detection (*t*-test), factor detection (F-test), ecological detection (F-test), and interactive detection. Risk detection is mainly used to explore whether there are differences in the RISU between different research units. Factor detection is used to identify the factors that contribute to the space variation of the RISU. Ecological detection can compare whether there are significant differences in the impact of different influence factors on the RISU. Interactive detection can identify the interaction between different factors; namely, it assesses whether any two factors that work together on the RISU will increase or decrease the explanatory force compared with the dependent factor or whether the impacts of these factors on the RISU are independent of each other (Wang & Xu, 2017).

3.3.3.2. Indicator selection. Based on the above theoretical elaboration in Section 2.2 and the actual situation of the Beijing-Tianjin-Hebei region, this paper chooses the total GDP (X_1) and the proportion of secondary and tertiary industries (X_2) to represent the regional economic factors. We take the total population (X_3) and the population urbanization rate (X_4) as population influence factors, and we select the per capita investment in fixed assets (X_5), the number of students in primary and secondary schools (X_6), and the number of health care beds (X_7) to represent regional social public service factors. In addition, the regional spatial accessibility (X_8), the scale of urban land (X_9), and urban construction level (X_{10}) stand for the space influencing factors in the research unit. The data algorithm of the geographical detector for categorical data is superior to that of continuous data. In this paper, the Jenks natural breaks classification method is used to discretize the attribute of each influencing factor, and the scale of RISU is the dependent variable. The detection results of the geophysical detectors show that when the attribute values of X_1, X_2, X_4, X_8, X_9 are divided into 8 categories, the attribute value of X_7 is divided into 7 categories, the attribute values of X_3, X_5, X_6 are divided into 6 categories, the attribute value of X_{10} is divided into 5 categories, and the statistical difference of the value of the corresponding factors were the most significant. In addition, because all the land types of the Dongcheng District, Xicheng District, and Tianjin municipal district are urban built-up land, these areas do not have the phenomenon of RISU. Because it was affected by the government's decision-making, the scale of RISU in Langfang municipal district in 2009 is much higher than that of the other regions in Beijing-Tianjin-Hebei. To avoid the adverse impact of extreme results, these four regions were removed from the geographical detector analysis (See Table. 1).

Table 1
Indicators for analysing the driving factors of RISU.

Type	Symbol	Indicator	Description
Economy	X_1	Gross Domestic Product (GDP)	An important indicator to measure the overall economic situation of a region.
	X_2	Proportion of secondary and tertiary industries	The proportional relationship to indicate the industrial structure of a region.
Population	X_3	Total population	The total number of people of a given geographical area.
	X_4	Population urbanization rate	The percentage of the urban resident population divided by total resident population of a region.
Public service	X_5	Per capita investment in fixed assets	The percentage of the total population divided by the total investment in fixed assets of a region.
	X_6	Number of students in primary and secondary schools	An indicator to indicate the level of education of a region.
	X_7	Number of health care beds	An indicator to indicate the medical level of a region.
Space	X_8	Regional spatial accessibility	The indicator to indicate the convenience of urban transportation in space linkages.
	X_9	Scale of urban land	The total area of all urban built-up land of a region.
	X_{10}	Urban construction level	The ratio of the area of urban built-up land to the area of urban and rural construction land.

4. Results and analysis

4.1. The temporal pattern of rural in situ urbanization

Viewed from the perspective of land use, the development of urbanization actually embodies the transformation process of other land use types for urban built-up land. In addition, the transfer from rural settlements to urban built-up land reflects the process of RISU from the perspective of land space bearing.

4.1.1. The overall change characteristics of rural in situ urbanization

During the study period, the total scale of RISU is 15,156.3 ha, which accounts for approximately 10% of all sources of urban built-up land, which is much lower than the proportion of 64.81% of agricultural land, such as cultivated land and woodland, which is driven by the low cost of occupation. From 2003 to 2015, the RISUI of Beijing-Tianjin-Hebei is as low as 0.1136. There is a convergence between the trend of the scale and index of RISU in each year (Fig. 3), and this trend is characterized from low to high and then to low. The scale and index of RISU in the period from 2007 through 2010 was significantly higher than that in the periods from 2003 through 2006 and 2011 through 2015. The RISUI in 2008 was 0.44, which is the highest over these years.

Early in the 21st century, the overall economic development level of the Beijing-Tianjin-Hebei region was relatively low. As economic construction at this time was more focused on the development of industry, the real estate market was soft; thus, the impetus for RISU was insufficient, and the form of RISU was mostly manifested as a passive transformation of land types under urbanization. In 2005, the Fifth Plenary Session of the 16th CPC Central Committee introduced a slogan of “building a new socialist countryside” (Ahlers & Gunter, 2013) and regarded it as a national task for building a thriving society in a comprehensive way (Hu, 2007). Therefore, the government vigorously implemented new village and small-town construction so that the degree of RISU improved steadily. However, the world financial crisis in 2008 caused the economic development of the Beijing-Tianjin-Hebei to suffer a setback (Sun, 2010), and the scale of RISU was drastically reduced. To alleviate the impact of the economic crisis, the government greatly increased investment in economic construction, which caused the real estate market to be unprecedentedly heated. Driven by the interest of real estate speculation, the construction of “houses with limited property rights” gradually spread (Ou & Zhou, 2014), and the scale of RISU increased substantially. However, under the current system in China, “houses with limited property rights” were not illegal, and after 2009, the Ministry of Land and Resources gradually halted and cleaned up those houses. In the context of this policy, the scale of RISU was greatly reduced. In recent years, driven by the policy of “link between rural-urban built-up lands” (Qu et al., 2013), the construction of a new socialist countryside has been in full swing, and it has gradually become an important form of RISU.

4.1.2. The level of change characteristics of rural in situ urbanization

On the county scale, we calculated the RISUI of all counties, and we used the Jenks natural breaks classification method to divide the index into the high, medium and low levels from high to low. We also determined the scale of RISU and the number of counties between different levels in the periods from 2003 through 2006, 2007 through 2010, and 2011 through 2015. The results conclude that the degree of RISU on the county scale is still at a low level, and the RISUI of most counties is below 0.18. Viewed from the distribution of RISU degree between different levels (Table. 2), the number distribution of counties in the former two periods shows an approximate pyramid-shape characteristic, and the counties that do not have RISU obviously have decreased in the third period. With the advance of time, the phenomenon of RISU in Beijing-Tianjin-Hebei is becoming more common; however, the degree of RISU remains to be improved.

Before 2010, a large number of people in the Beijing-Tianjin-Hebei region flocked to the central cities of Beijing and Tianjin, and with limiting policies (Lian, Li, Gong, Wang, & Sun, 2010), the inclination of rural development tended to be weak; thus, the development of RISU was slow and extremely polarized. The difference of RISU's scale between different levels was highly evident. > 60% of the counties did not experience the RISU phenomenon; however, approximately 85% of the scale was concentrated in a small number of counties whose RISU levels were high or medium (Table. 2). With the development of the economy, most counties vigorously carried out the construction of infrastructure; thus, the conditions of RISU gradually improved, and the construction of a new socialist countryside was in full swing (Ahlers & Gunter, 2013). Therefore, in the period from 2011 through 2015, the number of counties with RISU was increased, but the scale was reduced, and the distribution of the scale between the different levels gradually became balanced. It can be concluded from the above results that although the area was wider, the scope and degree of RISU in all the counties were still relatively low.

4.2. The spatial pattern of rural in situ urbanization

The spatial difference of RISUI between 2003 and 2015 is shown in Fig. 4. From the perspective of space, the degree of RISU for most of the areas in Beijing-Tianjin-Hebei is generally low, and most of the RISUI are between 0.00 and 0.18, while some counties do not exhibit the phenomenon of RISU at all. The areas with a higher degree of RISU are mainly distributed in Langfang, Hengshui and Qinhuangdao municipal districts and their surrounding areas. The spatial autocorrelation

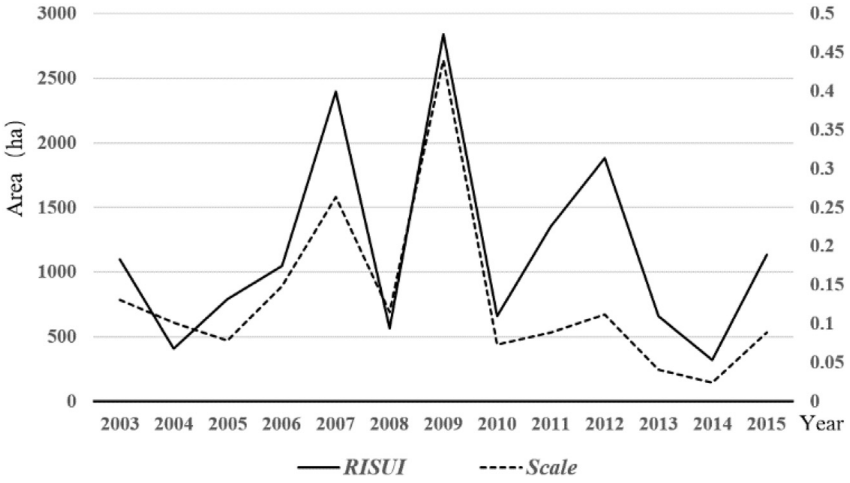


Fig. 3. The change of the scale and index of RISU in Beijing-Tianjin-Hebei.

Table 2
Level change of rural in situ urbanization in Beijing-Tianjin-Hebei.

Rural in situ urbanization level	RISUI	2003–2006		2007–2010		2011–2015	
		Number	Scale/ha	Number	Scale/ha	Number	Scale/ha
High	(0.50, 1.00]	7	1238.11	6	3843.49	4	629.81
Medium	(0.18, 0.50]	8	1625.83	19	1649.78	11	1622.10
Low	(0.00, 0.18]	28	479.16	36	971.47	118	3096.56
None	0	130	0	112	0	40	0
Grand total	–	173	3343.1	173	6464.74	173	5348.47

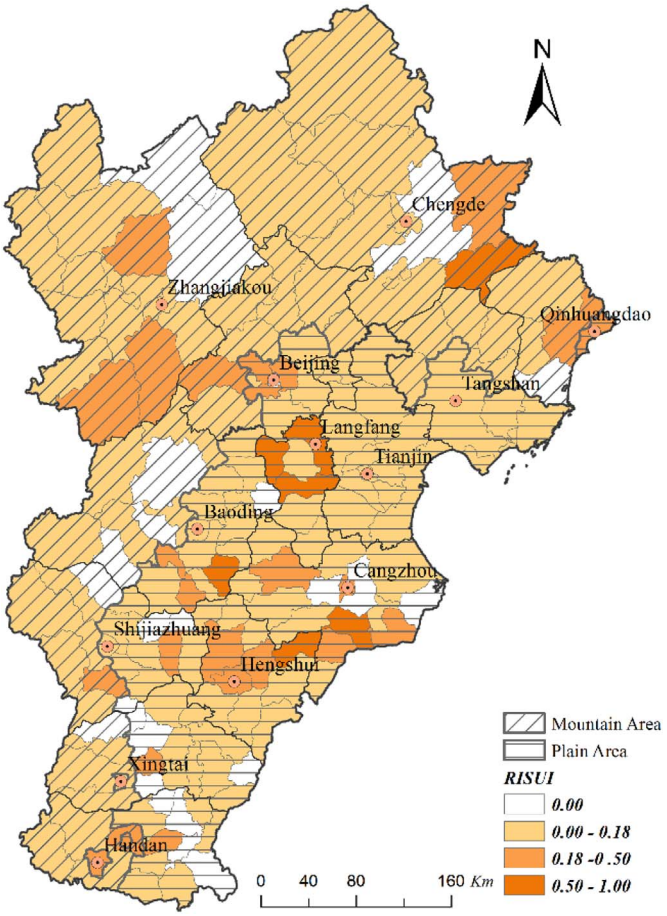


Fig. 4. Spatial difference of RISUI in Beijing-Tianjin-Hebei in 2003–2015.

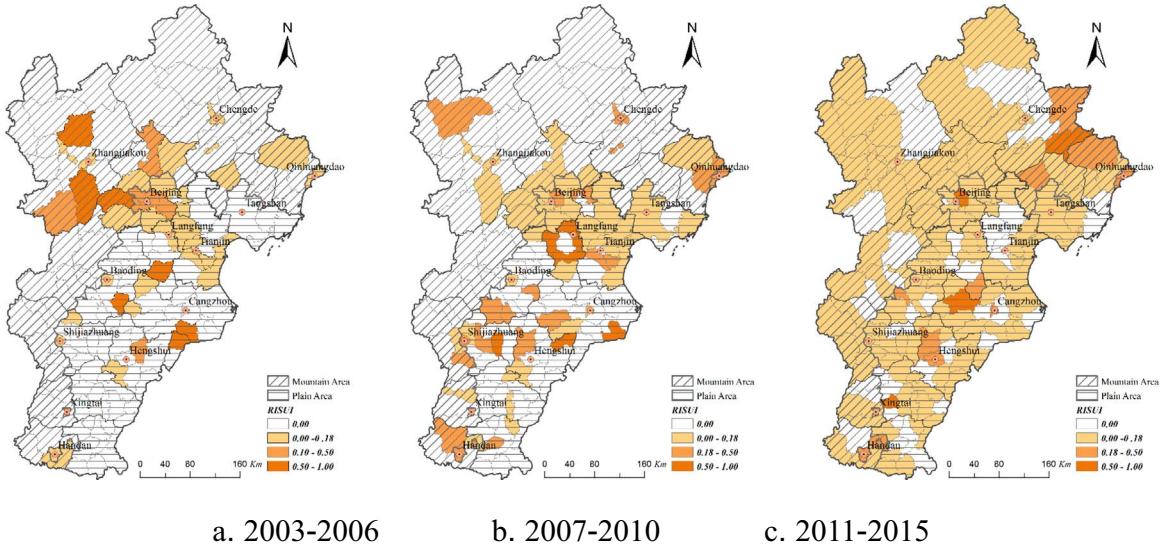
method is used to analyse the spatial agglomeration characteristic of RISU. The results show that the Global Moran's I index of the RISUI in Beijing-Tianjin-Hebei is approximately 0.13 ($P < 0.01$), and the Z value is 3.00, > 2.58, which indicates that the RISUI of Beijing-Tianjin-Hebei displays significantly positive spatial agglomeration.

Fig. 5 shows the spatial differentiation and its evolution of RISUI in Beijing-Tianjin-Hebei. We find that the space scope of RISU gradually expands to the periphery from point to surface with Beijing as the core. During the period from 2003 through 2006, RISU existed mainly in the eastern and central regions of Beijing-Tianjin-Hebei, and its space scope continued to expand in the period from 2007 through 2010; the phenomenon of high-level RISU appeared in some areas in the southern zone. From 2011 through 2015, RISU in Beijing-Tianjin-Hebei was quite common.

Due to the difference in the natural background condition, economic development and policy context among different regions, the geographical difference of RISU is evident. In the period from 2003 through 2006, the overall degree of RISU was low, and the counties with a high degree of RISU were mainly distributed in Lixian, Wen'an County, the Mentougou district and other central areas in Beijing-Tianjin-Hebei. During this period, urban development paid more attention to economic benefits and less attention to resources and environmental benefits, and when urban sprawl overly relies on the occupation of farmland and other agricultural lands, land urbanization shows a non-healthy state. Physiographic conditions are the basis for the formation and development of towns. Due to terrain space constraints, investment costs, and engineering construction difficulties, the RISU in the period from 2007 through 2010 existed mainly in the eastern plains and less in the western and northern mountainous areas. The areas with a high degree of RISU were mainly located in the Langfang municipal district, Bazhou city and Gu'an county. In the period from 2011 through 2015, the scope of RISU continued to expand, and at the same time, regional differences gradually decreased. However, the overall scale of RISU is small, and the degree in most counties are still generally low; these areas remain to be further developed for RISU in the future.

From the perspective of agglomeration type, the high–high type is mainly distributed in Langfang municipal city and Gu'an county, and the high–low type is in Xingtai County (Fig. 6). The terrain of these areas is mainly plains, where the physical and geographical conditions of urbanization development are superior. Langfang and its surrounding areas are located in the throat of Beijing and Tianjin, whose main zoning functions are as an optimized development zone and key development zone. Urbanization construction develops rapidly under the comprehensive influence of policy advantages and the economic spillover effect of Beijing and Tianjin (Zhang, Zheng, Song, & Zhong, 2016). In addition, the easing of Beijing's non-capital function has led to the transformation and upgrading of industrial development, and the settlement of Beijing-Daxing International Airport and Beijing-Tianjin-Hebei International Logistics Trade City will bring new opportunities for the development of urbanization in the region. Since 2009, Langfang combined rural land consolidation with new residential construction, took the link between rural-urban built-up lands as a starting point, and vigorously carried out the renovation of squatter settlement and the construction of villages and small towns, which greatly accelerated the process of RISU.

The low–low agglomeration type is mainly distributed in the north of Baoding, west of Zhangjiakou, north of Xingtai and the Chengde municipal district (Fig. 6), which are mainly located in the Taihang Mountain range and Yanshan Mountain range, where the main zoning function is the key ecological functional area. The terrain is the fundamental factor that restricts RISU in these areas, which results in poor infrastructure and a higher cost of urbanization construction. More importantly, under the siphon effect of the large cities such as Beijing, increased population and resource outflows, the demand for construction land in the region is relatively low. Combined with the urban construction restrictions that are imposed by the ecological red line, the degree of RISU is also relatively low. The low–high type is located in the central plain of Beijing-Tianjin-Hebei, mainly due to the high degree of urbanization around these areas.



a. 2003-2006 b. 2007-2010 c. 2011-2015

Fig. 5. Spatial difference of RISU in different periods in Beijing-Tianjin-Hebei.

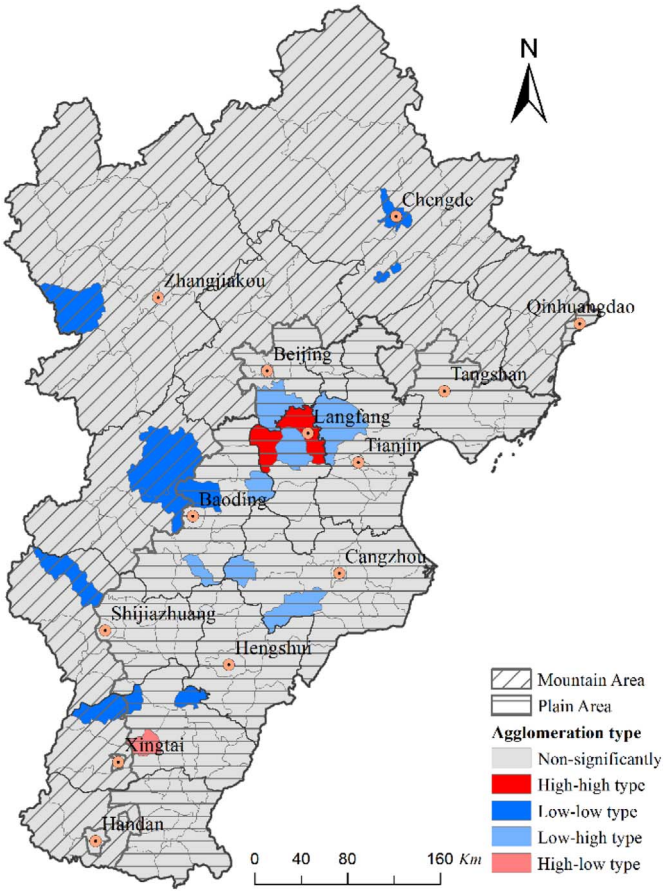


Fig. 6. The space agglomeration of RISUI in Beijing-Tianjin-Hebei.

4.3. The driving mechanism of rural in situ urbanization

After the discretization of the attribute value of RISU influence factors, the risk detection, factor detection, ecological detection and interactive detection analysis are conducted using the geographical detector method to comprehensively reveal the driving mechanism of RISU.

A risk detector can reveal significant differences in the impact of different factors on RISU. The results show that all the influence factors that we chose have a significant influence on RISU and passed the 0.01 level significance test. Different levels of factors indicate a significant difference in the impact of RISU. A factor detector reveals the influence of each factor on the degree of rural localized urbanization. The factor detection result of RISU (Table. 3) shows that the $P_{D,H}$ of all the influence factors passed the significance test at a level of 0.01. Among all the factors, the explanatory force of the total population (X_3) and the number of health care beds (X_7) on RISU is relatively strong, and its $P_{D,H}$ values are 0.444 and 0.407, respectively, which indicates that the influence of population and education standards on RISU are more important than those of other indicators.

The results of factor detection show that the explanatory power of GDP and the proportion of secondary and tertiary industries to RISU are 0.380 and 0.316, respectively, which indicates that the economic scale and structure have a significant influence on RISU: the better the economic development condition, the larger the scale will be. Because of the developed economy, excellent social public service and highly concentrated population in Beijing, Tianjin and all the municipal districts, investments in these areas in urbanization construction are high, and the scale of RISU accounted for 66.4% of the total of Beijing-Tianjin-Hebei. However, the average GDP of national poverty-stricken counties, such as Haixing county and Shangyi county, is < 35 billion yuan, and regional economic development seriously lags behind. The process of urbanization is also relatively slow; therefore, the scale of RISU is extremely low or even tends towards zero. Economic development is the most fundamental reason for RISU and the basis for

Table 3
Factor detection result of RISU. The ** indicates that the $P_{D,H}$ passed the significance test at a level of 0.01.

Indicator	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
$P_{D,H}$	0.380**	0.316**	0.444**	0.345**	0.230**	0.253**	0.407**	0.256**	0.382**	0.319**

promoting urban land sprawl; thus, it ensures the employment of the population, which attracts and stabilizes the regional labour force.

The explanatory power of the total population and population urbanization rate on RISU are 0.444 and 0.345, respectively, which indicates that population factors have a significant impact on RISU. The scale and migration of population have a direct guiding effect on the spatial sprawl of urbanization. In Beijing-Tianjin-Hebei, 76.1% of the population is concentrated in the central and eastern plain area, where the proportion of RISU is as high as 84.3%. The migration and agglomeration of population is not only a characteristic but also an important driver of urbanization. The labour force is the basic element of regional economic development, and its space location can bring a strong demand for urban land, which will increase its scale and further accelerate the process of RISU.

The explanatory power of the number of students in primary and secondary schools and the number of health care beds are 0.253 and 0.407, respectively, which indicates that education and medical standards have a certain influence on RISU. Under the Chinese traditional thought of “hope one's children will have a bright future” and the background of fierce competition for talent, parents attach great importance to their children ‘s education; thus, the education standards are often the decisive factor of parents’ residence and employment choices. Peasants, in particular the elderly, regard medical care, which is an important social security issue, as an important consideration when making the choice of RISU. Peasants are a micro-level subject of RISU, and the level of social public service affects the development of RISU by influencing peasants' urbanization willingness.

Spatial influence includes two aspects: spatial accessibility and land space bearing, which mainly affects the spatial distribution and scale of RISU. The relationship between towns and main external traffic arteries directly affects the possibility and intensity of economic drivers from external factors and determines the conditions of urban development. Urban built-up land, as the spatial bearing of urbanization, reflects the regional urbanization development level from the perspective of land. Under the current situation, in which land resources are extremely scarce, land urbanization exerts a momentous influence on promoting the development of urbanization.

The results of ecological detection indicate that the differences of the impact of most of the factors on RISU are not significant, and the factors have a certain interaction among them. Then, we used the interactive detector to analyse the interaction impact of the factors on RISU. The results (Table. 4) show that the $P_{D,H}$ of GDP (X_1) and population urbanization rate (X_4) are the largest, reaching 0.678, which indicates that population migration that is caused by an economic gap is the most important factor that affects RISU. The $P_{D,H}$ of the scale of urban land (X_9) and the total population (X_3), and the population urbanization rate (X_4) are 0.632 and 0.639, respectively, only < 0.678, which indicates that the urban land sprawl under the guidance of population has an important influence on RISU. The $P_{D,H}$ of the proportion of secondary and tertiary industries (X_2) and the total population (X_3) is as high as 0.606, which indicates that population migration caused by the economic gap also has a great effect on RISU. The results of interactive detection also show that the interactive influence between any two factors from population, economy, social public service and space is greater than the influence of a single factor on RISU, and the influence after the interaction of any two factors is expressed as a nonlinear enhancement. Economic development is the basis to achieve population attraction and the improvement of social public service, and the improvement of social public service is an important condition to attract population and its steady subsistence. Spatial factors mainly affect the direction of population migration and economic development from the perspective of geographical space and further influence RISU. In conclusion, the RISU in Beijing-Tianjin-Hebei gradually develops under the comprehensive influence of various factors such as population, economy, social public service and space.

5. Discussion and conclusion

Current studies mostly discuss the urbanization of large cities while ignoring the phenomenon of RISU in medium-sized cities, small cities, towns and villages (Brockerhoff, 1996; Murzin, 2014; Zhu, 2004). RISU is a new type of urbanization that plays a crucial role in the healthy development of urbanization. Study on the spatial pattern and driving mechanism of RISU can enrich the research system of RISU and provide a theoretical reference and policy suggestions for the implementation of urbanization. This paper studied RISU from the perspective of land use, explored its spatial pattern by the method of spatial autocorrelation, and discussed its driving mechanism by geographical detectors. The results answered the questions about the spatial pattern and driving mechanism of RISU and their differences with those of traditional urbanization. The conclusion and discussion are as follows.

In general, the overall RISUI of Beijing-Tianjin-Hebei in the period from 2003 through 2015 was relatively low, and the scale and index of RISU showed a trend of fluctuation from low to high and then to low. Although RISU on the county scale was conducted universally, the process was slow and mainly affected by socio-economics and policy, and the scale and degree of RISU needed to be further improved. The slow progress of RISU contributed to the deluge of migration urbanization to some extent, which further caused “city diseases” in large cities (Xing & Zhang, 2017; Yu et al., 2017), such as population explosion, traffic congestion, housing shortages, environmental deterioration, and resource shortages, with particularly serious and impressive impacts in Beijing and Tianjin. Those problems, in turn, raised much urgent demand for RISU. As an effective solution to the problem of “city diseases,” the promotion of RISU is imperative.

Viewed from the perspective of space, the number distribution of counties between different levels of RISU showed a characteristic pyramid-shape, and the spatial scope of RISU expanded to the periphery with Beijing as the centre. The high–high agglomeration type was mainly distributed in the central areas of Beijing-Tianjin-Hebei, such as the Langfang municipality district, while the low–low agglomeration type was mainly located in the mountain areas of Baoding and

Table 4
Interactive detection result of RISU.

Indicator	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	0.380									
X_2	0.581	0.316								
X_3	0.526	0.606	0.444							
X_4	0.678	0.502	0.626	0.345						
X_5	0.543	0.404	0.575	0.512	0.230					
X_6	0.568	0.590	0.535	0.543	0.454	0.253				
X_7	0.581	0.564	0.593	0.522	0.497	0.530	0.407			
X_8	0.565	0.459	0.554	0.513	0.446	0.555	0.550	0.256		
X_9	0.550	0.538	0.632	0.639	0.552	0.615	0.614	0.576	0.382	
X_{10}	0.594	0.381	0.601	0.497	0.359	0.571	0.587	0.446	0.502	0.319

Zhangjiakou. Due to the obvious regional differences in physical geography, policy and system, infrastructure among the central, western and northern parts of Beijing-Tianjin-Hebei, and the combined influence of siphon and spillover effects in Beijing and Tianjin, there were significant differences in the development of RISU between different regions and different levels.

From the perspective of main function zoning, the central and eastern areas of Beijing-Tianjin-Hebei were key development zones and mainly optimized development zones that should emphasize the transition from scale expansion to quality improvement. Nevertheless, the low degree of RISU made it difficult to form an urban development pattern of high density, agglomeration and contiguity, which was not conducive to the optimal utilization of urban land. Meanwhile, the western and northern mountain areas are mainly zones of agricultural production and key ecological function zones that require strict control of urban sprawl and attached importance to the consolidation of rural settlements. If RISU develops slowly, intensive urban development and regional economic growth will be constrained. In the future, RISU should be combined with main function zoning to guide reasonably populated concentrated living areas and industrial agglomeration development and thereby build a balanced, harmonious and sustainable land space pattern.

The results of using a geographical detector to analyse the influencing factors of RISU showed that RISU in Beijing-Tianjin-Hebei was influenced by the comprehensive effect of population, economy, social public service and space. In addition, the explanatory force of population was the largest, and the force of urban space radiation capacity was the smallest. Economy was the most fundamental reason for RISU, and it was the basis for population migration and social public service improvement, while population migration directly guided the space sprawl of urbanization. Due to the higher economic income and excellent social public service of the metropolises in Beijing-Tianjin-Hebei, a large labour force accumulated there, which significantly improved regional economic development. Meanwhile, under the policy of “people linked to land planning,” these metropolises obtained more urban land quotas, which in turn further accelerated the space sprawl of RISU. In contrast, regarding the urban land quotas of areas where labour forces outflows were comparatively small, economic development was limited. These areas lacked the primary conditions to carry out RISU as a result of the investment in the construction of social public infrastructure. At present, Beijing-Tianjin-Hebei's metropolitan area (Jia & Yun, 2015; Lian et al., 2010) does not form a reasonable city hierarchy system, and the trend of polarization between cities is serious. Beijing and Tianjin are economic growth hubs, and their economic “siphon effects” have caused the formation of a “poverty belt around Beijing Tianjin.” At the same time, the economic radiation effects of other large and medium cities on their surrounding areas are not strong; thus, RISU has been difficult to promote on a massive scale.

There are obvious differences in the spatial pattern and driving mechanism between RISU and traditional urbanization. The traditional urbanization mainly occurs in urban hinterland and fringe and spreads from the inside to the outside (Buyantuyev et al., 2010; Jiang, Ma, et al., 2016) taking the urban area as the centre, but RISU mainly occurs in the rural hinterland, and with the advance of time, its development between different regions gradually becomes balanced. Considering the driving mechanism, although the population and economy have an important influence on the development of urbanization and RISU (Li et al., 2015), there are differences in the initial driving force and the transmission mechanism. Traditional urbanization takes the agglomeration of population as the basis to drive the development of the industry, and the urban infrastructure and public service facilities are continuously improved in the process (Li & Long, 2014; Long, 2012). On the basis of the rural transformation and development, RISU requires the construction of infrastructure and the promotion of public service capacity as the basic premise, to meet people's living standard (Long, Li, & Zou, 2011). In addition, rural areas need to cultivate and strengthen advantageous industries and increase employment opportunities to attract the agglomeration of population as well as to improve the development of the urbanization. Traditional urbanization pays more attention on the role of the market mechanism (Kadi, 1988; Portes & Roberts, 2005), but the process of RISU, particularly in its early stage, requires the government's policy support and economic investment (Hu et al., 2014; Hu & Wen, 2015). In fact, traditional urbanization and RISU are not completely opposed, but they can complement and coordinate each other to promote the healthy development of urbanization. Based on the situation that economic demand is strong but resources and environmental bearing is limited, Beijing-Tianjin-Hebei should promote the coordination of all cities and small towns and take the path of new urbanization that combines migration urbanization with RISU.

China is a country with a large population and a great amount of land, as well as a series of social problems, such as city diseases that are caused by urban sprawl in different regions, and the situation is thus more serious and complex; thus, the demand for RISU is much greater. In the future, the government should emphasize the coordinated development of urban and rural areas and adopt RISU as an indispensable supplement of new urbanization to offer space for urban sprawl. The implementation of the link between rural-urban built-up lands and rural land consolidation should consider “land as the root of construction” and rely on the foundation of resources, environmental bearing and land space construction to achieve the optimal utilization of land resources. However, the development of RISU should “vary from place to place” and combine with the main functional zoning to shape various urban development strategies. Meanwhile, the driving mechanism of RISU should be the basis for the reasonable regulation of its development. In practice, the state should make economic development a key issue and accelerate the formation of multi-level urban hierarchy systems to exert leading roles in central cities on RISU. Furthermore, population migration can be used to guide a rational layout of towns, and infrastructure and social public service, as the material basis of RISU, should be improved as soon as possible. The state should provide some system and policy guarantees to ensure the smooth operation of all relevant aspects. Small towns, as important carriers of RISU, should promote land circulation and the equalization of public service and gradually decrease the threshold of peasants who are settled. It should also establish a unified construction land market, household register system and social security system between urban and rural areas to ensure the effective promotion of RISU. Only in this way can we promote the healthy development of urbanization and the integration of urban and rural areas and gradually realize the goal of the common prosperity of the entire society.

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