

Article

# The Effects of Urban Sprawl on the Spatial Evolution of Rural Settlements: A Case Study in Changchun, China

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**Abstract:** Detailed analysis of continuous time-series data from regions undergoing rapid urbanization can accurately reveal spatial variations on short time scales. This study used the city of Changchun in Jilin Province, China, as a case study to analyze total and annual changes in area—especially decreases in rural settlement area—as well as regional differences in these changes and driving forces of rural settlement evolution. Quantitative analytical techniques include a dynamic percentage of rural settlements, the distribution index of rural settlements, the regression correlation analysis, and other spatial analysis methods. Data were derived from a variety of sources, including land-use databases and social and economic statistics. The results show that the area of rural settlements decreased between 2009 and 2014, with the urban construction land expansion and decreases in cultivated lands. Rural settlements also became increasingly fragmented after 2009. Most of the rural settlements were located close to the urban construction land, and changes in rural settlement area were more pronounced with decreasing distance to the closest urban construction land, illustrating the effect of urban sprawl on rural settlement changes. The analysis also shows that the decreasing area of rural settlements between 2009 and 2014 is directly caused by urban sprawl. Regional development strategies and urban planning indirectly contribute to changes in the scale and spatial distribution of rural settlements by guiding urban development. The geographical environment and strict cultivated-land-protection policies also indirectly restrict changes in rural settlements by determining the restrictive area of urban expansion. No significant changes were found in the influence of population change on changing areas of rural settlements. In conclusion, the interaction of strategy for social-economic development, natural geography environments, and human demand jointly caused changes in rural settlements.

**Keywords:** rural settlements; spatial evolution; urban sprawl; Changchun city; distribution index; regression correlation analysis

## 1. Introduction

As rural populations inhabit rural settlements, the characteristics of these areas are the result of interactions between human activities and the natural environment [1]. Under the guidance of Land-Use and Land-Cover Change Project (LUCC) and Global Land Project (GLP), rural settlement land-use change and its driving forces have always been of considerable interest [2–7]. Research in this area has primarily focused on the following themes: (1) the temporal and spatial evolution of rural

settlements and its driving forces [8–16]; (2) the contradiction between decreasing rural populations and increasing rural settlements, as well as the optimal allocation of rural settlement land-use (e.g., hollow villages, land-consolidation-potentiality) [17–23]; and (3) the influence of changing land use and land cover on the local landscape, regional environment, and global environment [15,24–27]. Current researches into the temporal and spatial evolution of rural settlements mainly focus on the increasing rural settlement area and land-use changes over various time intervals. However, few studies have considered the evolution of the decreased rural settlements, for instance, decreased rural settlements in areas subject to rapid urbanization, especially the dynamic changes associating with the conversion of rural settlements during urbanization, which has its significance [14,28].

Southeast coastal areas and metropolis cities are the most typical regions for urbanization in China, with the developed frame of city groups that has already been basically formed. But the urbanization in North China is slowly going on with the mode of city groups. In the process of urbanization, the spatial pattern of regional land-use shifts dramatically [15,29,30]. In the suburb of a city, rapid urbanization has had a drastic effect on the spatial evolution of rural settlements, and the evolution of rural settlements is also an objective reflection of the urbanization. The spatial patterns of rural settlements are affected by rapid urbanization and thus exhibit unique characteristics. In-depth studies of rural settlement trends, and the driving forces behind these changes in areas undergoing rapid urbanization, make it easier to accurately define regional land-use issues and thus guide management decisions for rural land use.

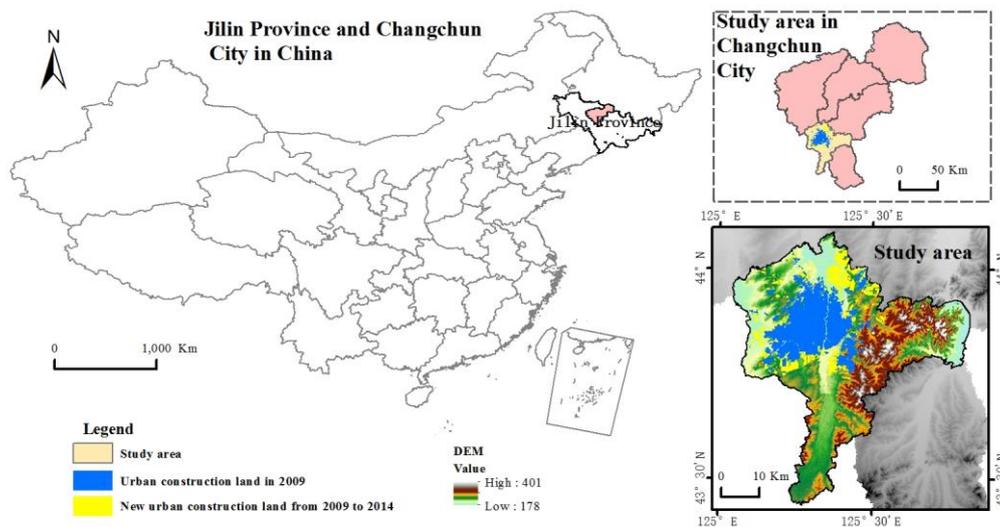
Using the main urban region of Changchun, Jilin Province, China, as a case study, we analyzed the changes in total area, patch numbers, and land dynamics of rural settlements from 2009 to 2014, that have occurred since the implementation of the “Chang-Ji-Tu” strategy (also known as the “Development planning outline for regional cooperation in Tumen River area, China—Changchun-Jilin-Tumen open development pilot zone”). This analysis was used to identify the characteristics of the spatial evolution of rural settlements in Changchun from 2009 to 2014 and explore its driving forces, providing a case study. The land-use policies in areas undergoing rapid urbanization have been developed to provide a theoretical framework to guide the process of urbanization, as well as establish policies for regional land management.

## 2. Materials and Methods

### 2.1. Study Area and Data Sources

#### 2.1.1. Study Area

As shown in Figure 1, the city of Changchun is located on the Ytong river terrace and in central Jilin Province, a northeast province of China. This area spans the region from mountains to the east to the Songliao Plain to the west, and is located on the hinterland of the northeastern Songliao Plain. The terrain generally decreases in elevation from east to west, with 70% composed of high terraces and 30% of plains. The city is between 250–350 meters above sea level, in an area dominated by a northern temperate continental monsoon climate. Changchun is the capital of Jilin Province, and comprises seven districts, two cities, and a county. Changchun is the most economically developed and fastest growing urban region in the province, with a total area of 20,604,000,000 m<sup>2</sup>. The study area is centered on the main urban region of Changchun, and includes the Lvyuan, Chaoyang, Kuancheng, Erdao, and Nanguan districts. The study area is an administrative region, so it not only includes urban and rural construction lands, but also other land use types that exist, such as the green space and cultivated lands. The urban fringe, a transitional region between the urban district (city) and traditional agricultural areas (rural settlements), is included in the study area, with landscape patterns that are a hybrid between urban and rural land-use. Urban construction lands in the study area increased by 141,170,000 m<sup>2</sup> from 2009 to 2014, and a majority of new urban construction lands were located in the low terrain and flat region.



**Figure 1.** Location of the study area and the urban construction land, 2009–2014.

### 2.1.2. Data Sources

Data sources used in this study include the second national land survey database for Changchun City in 2009 and a detailed land survey database for Changchun City from 2010 to 2014. Changes in rural settlement area were examined over the period 2009 to 2014. To compare data and ensure consistency, rural settlement spatial changes were examined over the period 2009 to 2014 (after the second national land survey in 2009, detailed survey methods and standards were consistent). This period represents a time of rapid urbanization in Changchun after formal approval of the “Chang-Ji-Tu” strategy.

Vector data for rural settlement areas and urban land-use were extracted from databases using ArcGIS, and socioeconomic and demographic data were obtained from the Jilin Statistics Yearbook and Changchun Statistics Yearbook. Some study data were also obtained from the Changchun City Master Plan (2011–2020) and the Changchun 12th Five-Year Plan for National Economic and Social Development.

## 2.2. Methods

The rural settlement, like the village, is a land-use type which mainly includes lands for living, public facilities, green, and other space in rural areas. It also includes vacant lands in the inner village. Rural settlement patches mean rural settlement plots whose borders are enclosed within building plots and other lands for farmers’ lives. ArcGIS software was used to examine the spatial evolution and changing areas of rural settlement around Changchun. These changes were described using the dynamic percentage of rural settlements, a distribution index of rural settlements, the regression correlation analysis and other spatial analysis methods. The driving forces behind the evolution of rural settlements were explored combining land-use, a Digital Elevation Model (DEM), demographic, and socioeconomic data.

### 2.2.1. Dynamic Percentage of Rural Settlements

The dynamic percentage is the percentage of the dynamic area accounting for the area of land-use type for analysis. Dynamic percentages of specific land use type were calculated and sorted according to the size of ratio, and then we could analyze the reason for the land-use change. Rural settlement dynamics are conversions of rural settlement land, including its source and destination. The sources of rural settlement land mainly include cultivated lands and other lands. The decrease of rural settlement land is mostly caused by the conversion to urban construction lands in the study area. To study the

dynamic percentage of rural settlements, a matrix of transition probability was calculated by ArcGIS 9.3 (Esri, Redlands, CA, USA). The dynamic percentages of rural settlements were analyzed combining the buffer analysis, which is one of the most important spatial analysis functions of ArcGIS 9.3. The source and destination of rural settlements at specified distances to the urban construction land were calculated using the following functions of GIS: Analysis Tools, Overlays, and Intersects [15,31].

### 2.2.2. Distribution Index of Rural Settlements

Distribution index of rural settlements (RSDI) is used to eliminate effects of regional area differences and reflect the spatial differences of rural settlements. The combination of a distribution index and the buffer analysis is also used to reflect the effect of influence factors. In this study, the analysis of RSDI was used to examine the correlation between the urban expansion and the spatial evolution of rural settlements. Its formula is [15]:

$$RSDI = \frac{S_{ie}}{S_e} / \frac{S_I}{S} \times 100\% \tag{1}$$

where  $S_{ie}$  and  $S_I$  represent the area of rural settlements in a secondary region and the total area of rural settlements in the study region, respectively, and  $S_e$  and  $S$  represent the total land area of a secondary region and the total land area of the study region, respectively.

In this study, when RSDI is 1, the area proportion of rural settlements in a secondary region is equal to the proportion in study area. If RSDI is greater than 1, the area proportion of rural settlements in a secondary region is greater than the proportion in study area, and this secondary region is a dominant area of rural settlements. If RSDI is less than 1, the area proportion of rural settlements in a secondary region is less than the proportion in study area, and this secondary region is not a dominant area of rural settlements.

### 2.2.3. Regression Analysis between the Change in Rural Settlement Land and its Driving Factors

Driving factors included the distance to the urban construction land, rural population, and the DEM. Relationships between the change in the rural settlement land and its driving factors were studied by using a regression analysis (Table 1). We calculated linear regression correlation coefficients between the change in the rural settlement area and its driving factors, to determine and compare their relevance. For example, we regressed the distance to urban construction lands and the change in rural settlement areas. Its formula is [16]:

$$AREA = \alpha X + \beta \tag{2}$$

where AREA is the changing area of rural settlement land,  $X$  is the driving factor, and  $\alpha$  and  $\beta$  are constants.

**Table 1.** Correlations between changing area of rural settlements and influence factors in Changchun, 2009–2014.

Changing Area (Area) of Rural Settlements	Distance to Urban Lands	DEM	Rural Population
Correlation coefficient	Area = 182.17x – 884.7 R = 0.83	Area = 158.85x – 803.16 R = 0.88	Area = 5.56x – 278.54 R = 0.38
Correlation	Significant correlation	Significant correlation	Weak correlation

Note:  $R^2 < 0.2$  = weak correlation;  $0.2 < R^2 < 0.5$  = correlation;  $0.5 < R^2 < 0.6$  = strong correlation;  $R^2 > 0.6$  = significant correlation [15].

### 3. Results

#### 3.1. Variability of Rural Settlement Area in Changchun

##### 3.1.1. Changes in Changchun Rural Settlement Area

As shown in Figure 2, the rural settlement area of Changchun decreased by 14,470,000 m<sup>2</sup> (−9.41%) from 2009 to 2014. Annual average variation in rural settlement area was −2,890,000 m<sup>2</sup> and −1.88% between 2009 and 2014, showing that the rate of change in 2009–2014 was significantly fast. The urban construction land area in Changchun continued to increase by 141,170,000 m<sup>2</sup> from 2009 to 2014, while the cultivated land area decreased by 112,290,000 m<sup>2</sup> during this period.

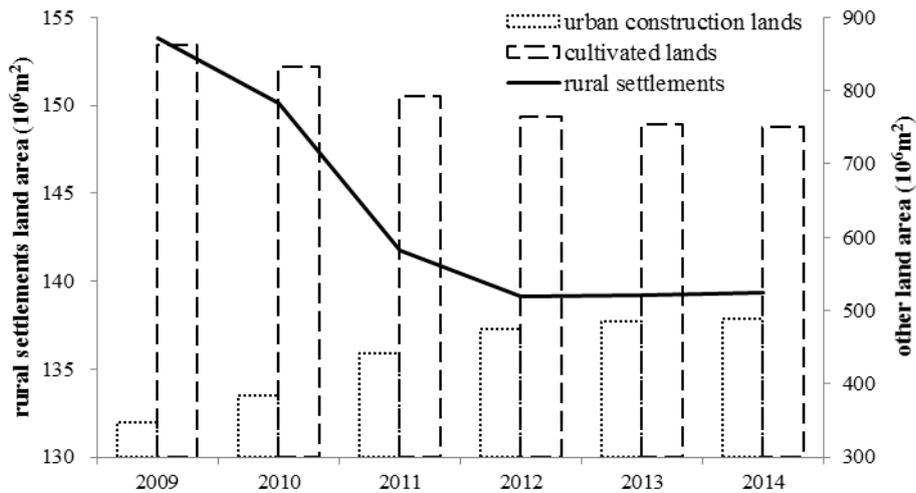


Figure 2. Changes in rural settlement and other land area in Changchun, 2009–2014.

##### 3.1.2. Changes in the Number of Changchun Rural Settlement Patches

The rural settlement area decreased from 2009 to 2014, while the number of rural settlement patches increased by 319. As shown in Figure 3, the number of rural settlement patches decreased slightly from 3710 in 2009 to 3646 in 2010. After 2010, the number of rural settlement patches reached 4029 by 2014.

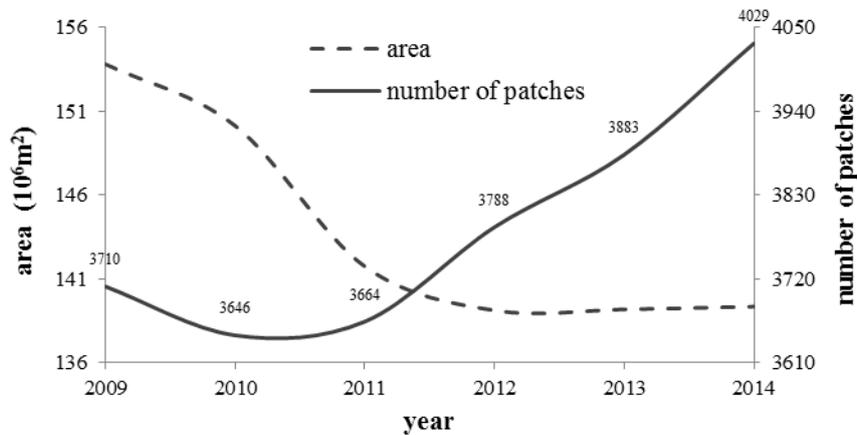
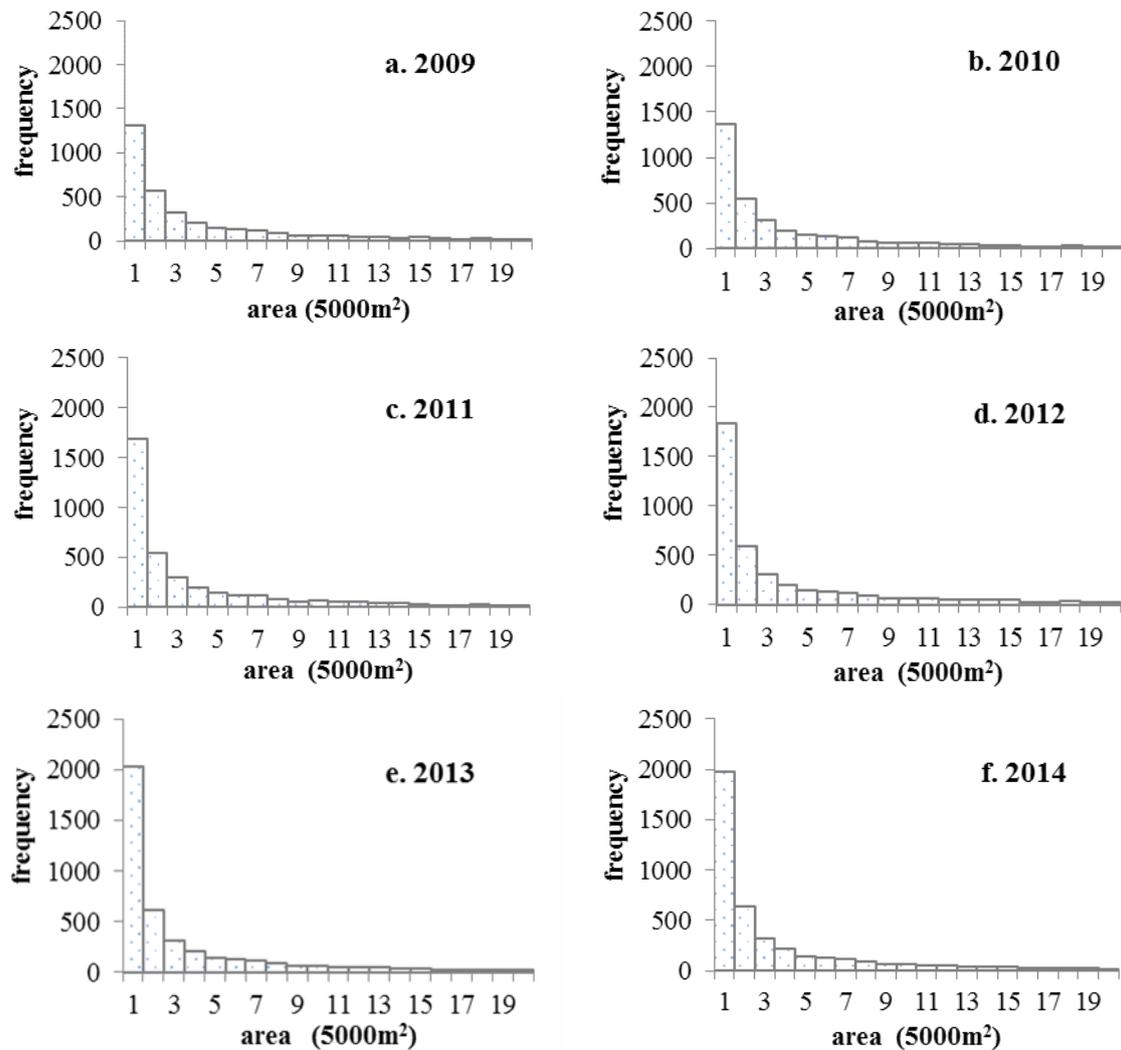


Figure 3. Changes in the number of rural settlement patches in Changchun, 2009–2014.

Figure 4 shows the frequency of the area of rural settlement patches at intervals of 5000 m<sup>2</sup> during 2009 to 2014. Over this time period, the areas of rural settlement patches were generally small but the

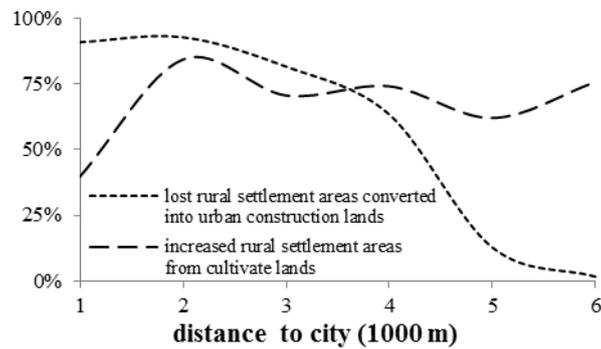
number of patches increased, with the most significant increase observed for patches with areas less than 5000 m<sup>2</sup>. The number of patches whose areas were more than 40,000 m<sup>2</sup> changed little during this time period.



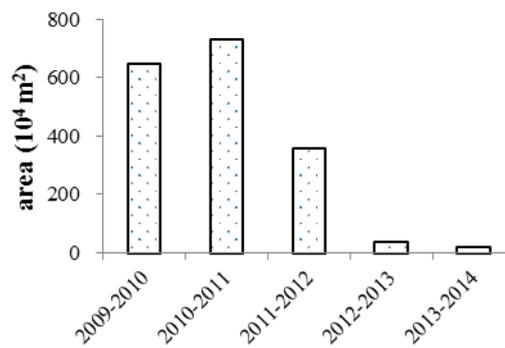
**Figure 4.** Histogram of the area of Changchun rural settlement patches, 2009–2014. (a) 2009; (b) 2010; (c) 2011; (d) 2012; (e) 2013; (f) 2014.

### 3.1.3. Rural Settlement Land Dynamics in Changchun

As shown in Figure 5, the majority of the increased rural settlements came from cultivated lands, which was common in the whole study area. The decrease in rural settlement area in the study region was mainly caused by urban expansion. About 85% of rural settlement area lost from 2009 to 2014 was converted into urban construction lands. As the distance to urban construction lands increased, this proportion of converted area from rural settlements to urban construction lands decreased. As shown in Figure 6, the greatest loss in rural settlement area due to urban sprawl occurred during 2010 to 2011. Since then, the loss in rural settlement area has continued to decrease.



**Figure 5.** Correlations between rural settlements land dynamics and the distance to urban construction lands in Changchun, 2009–2014.



**Figure 6.** Annual decrease in rural settlement area due to urban sprawl in Changchun, 2009–2014.

### 3.2. Spatial Change in Rural Settlements in Changchun

#### 3.2.1. Distribution of Changes in the Total Area of Rural Settlements

Analysis of spatial changes in rural settlement areas within different distances was used to determine spatial differences in the evolution of rural settlements in Changchun over different time periods. This analysis was also used to examine the correlation between the urban expansion and the spatial evolution of rural settlements.

The overall trend of the distribution index of rural settlement land was that the distribution index declined with increasing distance to urban construction lands (see Figure 7). Compared to regions whose distances to urban construction lands were more than 3000 meters, more rural settlements were located within the scope of 3000 meters to urban construction lands. This spatial characteristic of rural settlements was slightly changing during 2009 to 2014, but had not significantly changed yet. When the distance to the urban construction land was less than 3000 meters, distribution indexes of rural settlement land in 2009, 2010, 2011, 2012, 2013, and 2014 were sorted from large to small. However, if the distance to the urban construction land was farther than 3000 meters, distribution indexes of rural settlements in 2009, 2010, 2011, 2012, 2013, and 2014 were sorted from small to large.

The area of rural settlements located within the scope of 1000 meters of urban construction lands always decreased during the years 2009–2014 (see Figure 8). If the distance to urban construction lands was farther than 1000 meters, however, increases and decreases in rural settlement areas coexisted in suburbs. Also, decreases in rural settlement areas were greater in suburbs than outer suburbs during this time period. The total area changes were relatively large within the scope of 3000 meters to urban construction lands, which is very significant in the study area. The biggest decline in area of rural settlements was located within the scope of 1000 meters to urban construction lands. Then the slight declines existed in area of rural settlements located farther from urban construction lands. Increases in

area of rural settlements were mainly located in regions whose distances to urban construction lands were farther than 3000 meters, but the total area changes were relatively small.

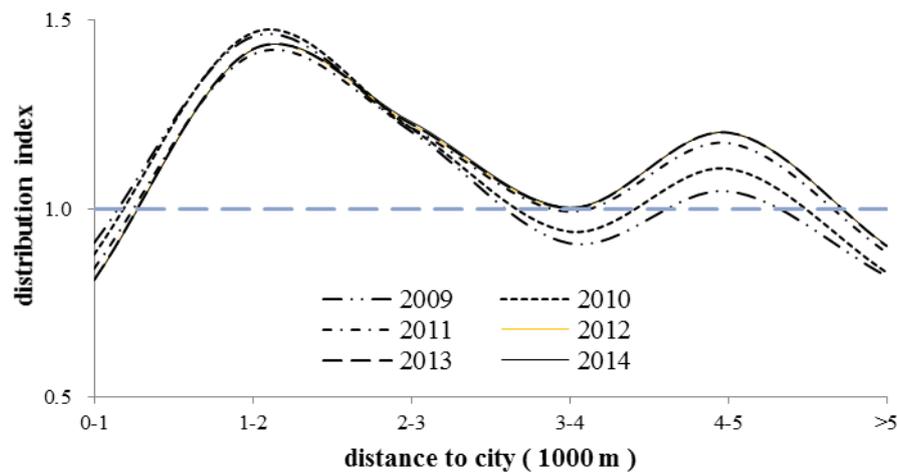


Figure 7. Distribution indexes of rural settlements in Changchun, 2009–2014.

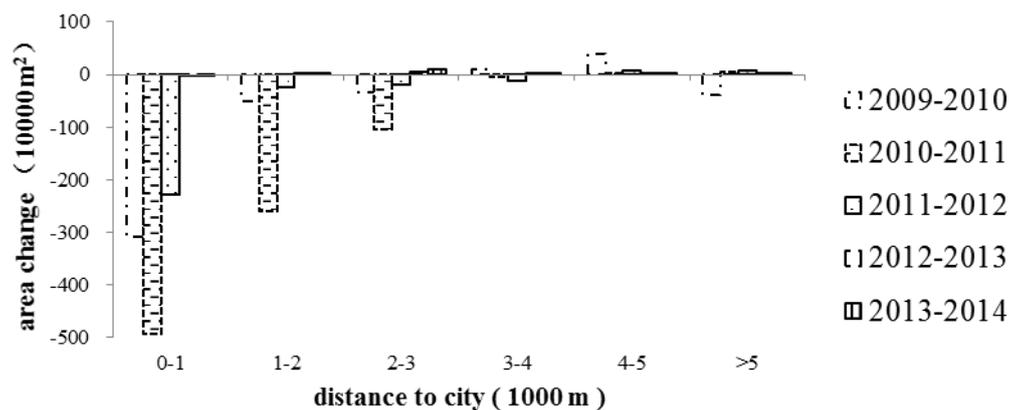


Figure 8. Spatial changes in the total area of rural settlements in Changchun, 2009–2014.

Variability of rural settlement area in 2009–2012 was larger than in 2012–2014. These results show that changes in rural settlements are affected by the speed of urban expansion, and clearly illustrate the effect of urban sprawl on the spatial evolution of rural settlements.

### 3.2.2. Distribution of Changing Area of Rural Settlements in Administrative Villages

The distribution of rural settlement area change and the range in area change of administrative villages for 2009–2012 and 2012–2014 are shown in Figures 9 and 10, respectively. The number of administrative villages with increased and decreased rural settlement areas were balanced in 2009–2012, and rural settlements located in the south, southwest, and northeast of Changchun City exhibited the most pronounced changes. Most rural settlement areas of administrative villages in urban fringes decreased, and the area change and range in area change were relatively large. Rural settlements of administrative villages in outer suburbs mainly increased in area. However, the range in area change was comparatively small, aside from in Jinqian Village in northern Changchun and Quanyan Town in eastern Changchun, where changes were slightly larger. The number of administrative villages with decreased rural settlement areas was lower than villages with increased rural settlement areas in 2012–2014, and rural settlements located in the southwest and northeast of Changchun exhibited the largest changes. Increases and decreases in rural settlement areas of administrative villages coexisted

in urban fringes, and the range in area change was relatively large. Rural settlements of administrative villages in outer suburbs mainly increased in area, but the area change and range in area change were relatively small.

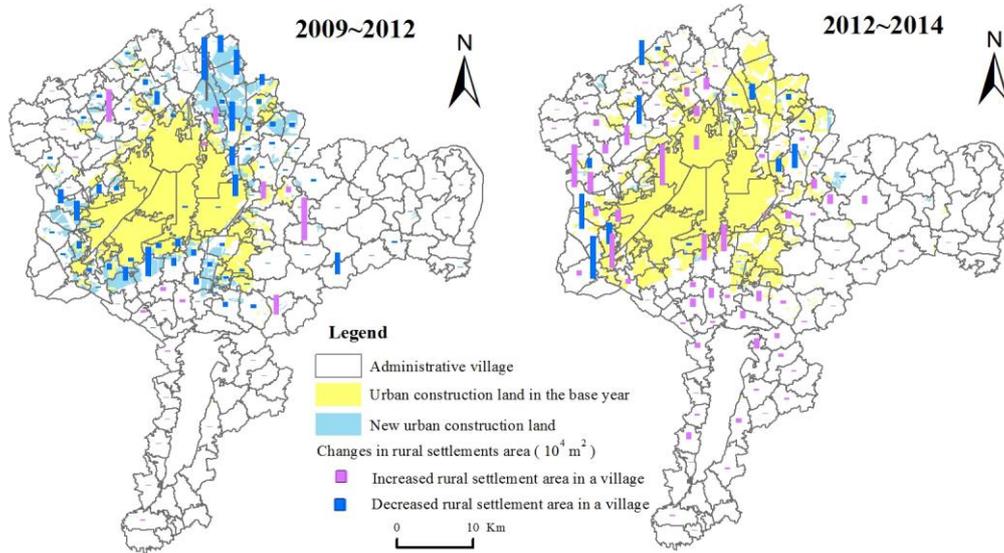


Figure 9. Spatial changes in rural settlement area of various villages in Changchun.

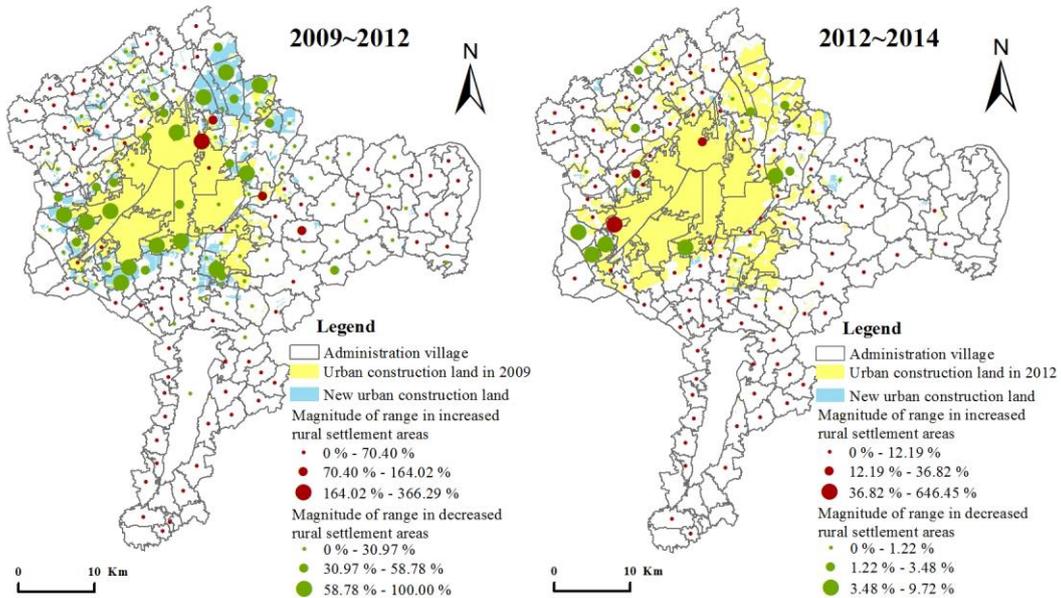


Figure 10. Range in area change of rural settlements in villages in Changchun.

### 3.3. Analysis of Multiple Driving Forces

#### 3.3.1. Roles of Urban Planning and Regional Development Strategies in the Spatial Evolution and Area Change of Rural Settlements

Generally speaking, the objective to policy-making is to meet the demand of economic development, but resulting concomitant construction lands expansion all along. The “Chang-northeast national open development pilot zone” in Changchun (hereinafter referred to as the “Chang-northeast”), which is included in the “Chang-Ji-Tu” strategy, encouraged urban construction lands to expand to northeast Changchun. The integration of Changchun City and Jilin City will be advanced, and a series of

spatial nodes will be built along the traffic corridor in the planning period under the “Changchun city master plan (2011–2020)”, such as Karen Technology and Ecological Park, Lotus Lake Eco-Tourism Resort, Longjia International Airport Industry Area, and Jiutai New Area, which encouraged urban construction lands to expand to east Changchun. According to the correlation analysis of the distance to urban construction lands and changing area of rural settlements, their correlation coefficient is 0.83, and they have a significant correlation over this time period. Decreased rural settlement areas were spatially consistent with urban expansion, suggesting that decreases in rural settlement area were mainly caused by urban expansion. Urban expansion caused the rural settlements to move away from the central city and resulted in conversion of rural settlements into urban construction lands and a decrease in rural settlement area. Therefore, under the economic development needs, urban sprawl encouraged by urban planning and regional development strategies is the direct cause of decreased rural settlement area over this time.

### 3.3.2. Effects of Geography and Cultivated Land Protection Policies on Changing Rural Settlements

Regional development strategies and urban planning will inevitably cause urban expansion to encroach on rural settlements, causing the rural settlements to gradually migrate away from the central city. However, the patterns of urban sprawl are also affected by local geography conditions. According to the correlation analysis of DEM and changing area of rural settlements, their correlation coefficient is 0.88 and they have a significant correlation over this time period. Big Black Mountain, for example, in the department of Changbai Mountain, is an ecological reserve within Changchun City that limits expansion of the city to the southeast. This reduces the occupation of the rural settlements by urban expansion, and helps to maintain the original spatial distribution of rural settlements.

Long’s study [26] shows that rural settlement land is one of the key resources for urban construction lands, and the increase in rural settlements mainly comes from cultivated land [7]; it is in the same situation in the study area. This process causes an initial change from cultivated lands into rural settlements, and then further conversion into urban lands. The cultivated land in and around Changchun is an important resource in northeast China, and urban sprawl would consume valuable farmland and jeopardize national food security. The cultivated land area of Changchun City is 14,630,000,000 m<sup>2</sup>, or 71% of the total land area. Farmland protection is a challenge both in Changchun as a whole and in the main urban region of Changchun, and the arable land protection policies in China are very strict, which would limit expansion of construction lands from farmland to a certain extent. From this perspective, arable land protection policies are important in restricting the increase in rural settlements.

### 3.3.3. Effects of Rural Population Change on Rural Settlement Area

According to Changchun demographic data, rural populations increased slightly from 761,400 in 2009 to 767,000 in 2011. Populations then decreased after 2011, reaching 759,200 in 2013. Although, according to the correlation analysis of rural populations and rural settlement area, their correlation coefficient is merely 0.38 and they have no significant correlation over this time period. In fact, they seemed to have slightly similar trends; i.e., when rural population increased, rural settlement areas tended to increase, and vice versa. Namely, the rural settlement land area must primarily meet the people’s needs for living space in rural area, which is also valid for changes in rural settlement area.

## 4. Discussion

Increases in rural settlements mainly refer to more built up lands being constructed in the outer village or new rural areas, followed by more rural settlements patches or areas manifesting. Flat areas with fine landscape are preferred regions for increases in rural settlements, such as cultivated lands. So, construction lands encroach on cultivated lands in the urban or rural expansion zones, which is very common in recent years [32]. However, with the implementation of policy and occurrence of urbanization, the urban construction land expanded a lot in the study area, while areas of rural

settlements and cultivated lands decreased from 2009 to 2014. According to statistics showing the conversion of rural settlements in Changchun, 83.72% of lost rural settlements in the study area were converted into urban construction lands during 2009–2014. And the changing rate of rural settlements and cultivated lands fit the rate of land urbanization. During the study period, as the distance from urban construction lands increased, the area of rural settlements eroded by urban construction lands decreased, but the percentage of rural settlement area converted from cultivated lands did not significantly decline. As shown above, when rural settlements are converted to urban construction lands, there are corresponding losses in cultivated lands. The result is that the cultivated land is lost in order to maintain the populations in rural settlements, which may indirectly damage the ecological environment. Further, any growth in rural settlements in suburbs increases the cost of urban construction in the future. Therefore, as urban sprawl consumes rural settlements and cultivated lands, policies must be in place to ensure work security and justice and equity in the land management, and management in adjacent rural settlements is also needed.

In general, changes in rural settlement areas occur accompanied by the patch number changes in China, they would increase or decrease at the same time [33–36]. The conversion from other lands to urban and rural construction lands caused increases in area and patch number of rural settlements. As the scale of rural settlements converted to urban construction lands was more than the new rural settlements in the study area, the result was that the total area of rural settlements decreased in Changchun, and at the same time, the patch numbers of rural settlements increased from 2009 to 2014, which is unique in the main urban area of Changchun, but not generally observed for other study areas in China. The total number of rural settlement patches in the study region did not decrease with ongoing urbanization. There were two reasons for this. Firstly, original rural settlement patches in suburbs have been fragmented due to urban sprawl. As a result, the number of rural settlement patches has increased while the area of rural settlements has decreased. Secondly, new rural settlement patches are mostly scattered and smaller. The fragmentation of rural settlement landscape is more and more significant in China [37,38], illustrating that the impact of human activities on the land use pattern has gradually strengthened. To control the change in scale and spatial pattern of rural settlements, archiving remote sensing imagery, regular observations, and field verification are needed to monitor this miniature changes in rural settlement land.

In addition, changes in the rural settlement area were greater in suburbs than outer suburbs, and there was a significant correlation between changes in total area of rural settlements and their distances to the urban construction land over this time period, illustrating urban expansion had a clear effect on changes in rural settlements. Future development planning for the region should therefore respect the natural landscape, consider both the city and the country in overall planning, wisely control the distribution of urban and rural land-use types, and realize the integration of urban and rural development. While regional development strategies and urban planning guided the scale and distribution of urban construction lands, they aroused corresponding changes in cultivated lands and rural settlements in the study area. The scientific and reasonable formulation of regional development strategies and urban planning are therefore important in terms of wisely managing regional land-use changes.

Recent research demonstrates that the correlation between rural settlement area and rural populations diminished [14]. However, in our study, the rural settlements need to meet the land demand of rural populations in the first place. Decreases in rural settlement area are caused by urban expansion encroachment and aren't driven by the rural depopulation, while there are widespread increases in rural settlement area beyond the urban expansion zones. At the request of land-use planning and land management, new rural construction land should give priority to existing potentiality. Further, rural homesteads are the traditional basic unit in rural settlements. The result of the present study therefore is affected by above conditions, and indicates that changes in rural settlement area do not have a clear relationship with rural population change. Considering these factors, additional study is still needed in the future.

## 5. Conclusions

With the implementation of policy and undergoing urbanization, the urban construction land expanded a lot, while the area of rural settlements and cultivated lands in Changchun decreased from 2009 to 2014. The rate of change was fastest at the beginning of the implementation of policy, then became slower and slower. After 2010, there was an increasing number of rural settlement patches and the number of patches with area less than 5000 m<sup>2</sup> increased significantly during the study period, illustrating the rural settlement land became more fragmented.

Overall, most of rural settlements were located close to the urban construction land, especially in the scope of 3000 meters. Due to the encroachment on rural settlements by urban expansion, the trend of the distribution of rural settlements gradually changed, but the overall trend didn't change. Also, a vast majority of decreases in the total area of rural settlements were located in the scope of 3000 meters to urban construction lands, and rural settlements located within the scope of 1000 meters to urban construction lands exhibited the most pronounced changes. For changes in rural settlement area of various administrative villages, rural settlements located closer to the urban construction lands had a higher variability in area, too. Rural settlements of various administrative villages located in urban fringes generally decreased from 2009 to 2012, but increases and decreases coexisted in rural settlements from 2012 to 2014.

There is a clear correlation between changes in rural settlement area and urban construction land expansion from 2009 to 2014, and urban sprawl is the direct cause of decreased rural settlement area over this time. Urban planning and regional development strategies indirectly guide changes in the scale and spatial pattern of rural settlements by guiding the direction of urban development. Local geography and strict arable land protection policies are the main limitations to changes in rural settlements by determining the restrictive area of urban expansion, but rural population change does not have a significant effect on changes in rural settlement area. In conclusion, the interaction of strategy for social-economic development, natural geography environments, and human demand jointly caused changes in rural settlements.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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