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Transitions in rural settlements and implications for rural revitalization in Guangdong Province

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ABSTRACT

Since the implementation of China's open-door policy in 1978, the number, structure, and environmental conditions of rural settlements have changed dramatically. This study examined the changes in rural settlements and the factors behind rural change in Guangdong Province using land-use datasets from 1980, 1990, 1995, 2000, 2005, 2010, and 2015, a digital elevation model, and data for transport networks and physical characteristics. Different stages of change in the rural settlements became evident: there was expansion from 1980 to 2000 and rapid decline from 2000 to 2010. Urban growth was facilitated by converting high-production cropland. The density of rural settlements was highest in areas with medium-level development: the density was highest in eastern and western parts of the province, lower in the center, and lowest in the north. The patterns and changes in rural settlements were most strongly related to water sources and transport systems; however, some physical variables (terrain, precipitation, and temperature) were significantly associated with the probability of occurrence of rural settlements. We argue that comprehensive, systematic planning systems should be established for rural areas and that it is necessary to recognize the value of the cultural heritage of southern Guangdong. To ensure the success of a rural revitalization strategy, it is important to introduce regional development schemes that resolve inequalities between less and more economically developed areas.

1. Introduction

Rural settlements are usually small groups of buildings in rural areas that play an important role in governing the spatial distribution of the local population; they provide multifunctional spaces for living, farming, and forestry (Porta et al., 2013; Tian et al., 2014; Yang, 2017). Since 1978, tremendous land-use changes in China have occurred following the implementation of the open-door policy (Long et al., 2009). Rural settlements, which are one of the most important land-use types in provincial areas, have been greatly affected by industrialization and urbanization. Earlier studies reported that before 1978, rural settlements showed very slow development rates owing to the lack of industry and China's traditional culture of four generations living under one roof (Long et al., 2007). Subsequently, rural settlements underwent rapid expansion owing to accelerated industrialization (Long et al., 2009). As a result of further urbanization and introduction of new economic policies, some researchers have stated that there is a general tendency for China's rural settlements to become more spatially aggregated; the number of villages has declined substantially (Tian et al., 2014; Yu et al., 2017).

Issues related to land-use changes and the relationship between land use and urbanization have attracted considerable interest among many researchers (Long et al., 2007). By contrast, questions regarding the transitions undertaken by rural settlements and associated driving forces have long been neglected. However, the transitions of rural settlements, which are closely associated with changes in spatial patterns and land use (Chen et al., 2017), highlight the relationship between humans and the countryside (Barbosa-Brandão et al., 2015); that field has gradually become one of great debate in geography (Jin, 1988; Tian et al., 2014; Yang et al., 2015; Zhu et al., 2016; Walters, 2017; Yang, 2017; Ma et al., 2018).

The distribution of rural settlements is a combination of geographic,

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physical, social, economic, and historical influences (Tian et al., 2014; Yang, 2017). Further, transition patterns in rural settlements vary according to different patterns of economic growth and sector structure. In 1978, for example, transition among China's rural settlements could be categorized as either slow or rapid growth (Long et al., 2007, 2009). In Uzbekistan, transitions of rural settlements have been characterized by an increasing proportion of the population becoming engaged in industrial and service sectors (Conrad et al., 2015).

In addition to policies and cultural norms, the localization of rural settlements has always been strongly dependent on the availability of resources and the regional environment (Domon, 2011). Increasing numbers of people around the world now migrate to new destinations if their living conditions change (Krivokapic-Skoko et al., 2018).

Since the economic reform policy was implemented in 1978, China has undergone rapid economic development and urbanization. To meet new economic and social demands, rural settlements have changed their functions and spatial structures (Gullino et al., 2018). These changes have resulted in many rural problems (Long et al., 2011; Liu and Li, 2017), such as the following: hollow villages (depopulated rural settlements that result when young adults and even some middle-aged men migrate to cities) (Liu et al., 2017); the disappearance of highly valued cultural heritage assets, (such as the replacement of historical buildings by modern Louvre-gallery-style buildings in Guangzhou's countryside) (Sun, 2017); and environmental pollution in rural areas (Long et al., 2011). As a form of land use, the restructuring of rural settlements is closely associated with urbanization and has been especially noticeable since 1978.

Researchers have analyzed the effects of urbanization on rural settlements; however, the long-term driving factors for transitions in rural settlements have consistently been neglected (Tian et al., 2014; Zhu et al., 2016). That has led to a lack of proper understanding about how and why rural settlements are changing (Ke et al., 2012). Doubts exist as to whether China's rural settlements are expanding, shrinking, or undergoing some other process. Socioeconomic and physical environments and development levels vary among China's different regions: more research needs to be conducted at the local level to allow appropriate reshaping of rural areas and resolution of the problems caused by the country's rapid economic development and urbanization (Ke et al., 2012).

Guangdong Province is one of the most developed areas in China. There are great variations in socioeconomic and environmental conditions and resources across the province: notably, stark contrasts exist between rural, mountainous areas in the north and modern urban areas of the Pearl River Delta. On December 4, 2017, the government instituted the Comprehensive Development Plan for Coastal Economic Belt of Guangdong Province for 2017–2030, which was a blueprint for economic development of coastal areas. That strategy is very detailed and includes a general plan; however, information about spatial distribution in the area, the main tasks that need to be achieved, and rural and northern mountainous areas were barely mentioned (Liu and Li, 2017). It is reasonable to assume that in the future, the trend of rural depopulation will continue and that rural settlements will continue shrinking; coastal areas will become ever more densely populated and prosperous. The heterogeneities in population, economy, and consequent ecological and environmental quality will become even more prominent; the differences between urban and rural areas will increase. In October 2017, in a report from the 19th National Congress of the Communist Party of China (CPC), the government outlined a strategy for revitalizing rural areas; it aimed to achieve high standards for living, rural civilization, clean and tidy villages, and democratic management (Wang and Zhuo, 2018). For China's countryside, that presents both unprecedented opportunities for development and challenges.

This paper is based on a case study of transitions in rural settlements in Guangdong Province. The aims were as follows: (1) to use a geographic information system (GIS) to examine how the spatial arrangement of rural settlements changed; (2) using logistic analysis, to explore the main driving factors for transitions in rural settlements; and (3) to discuss some of the main implications for the rural revitalization strategy of Guangdong Province. We hope to address the follow questions: (1) What kind of transitions have rural settlements experienced over recent decades? (2) What are the associated driving forces? This study aims to identify implications for rural revitalization in both Guangdong Province and China as a whole.

2. Materials and methods

2.1. Study area

Guangdong Province (20°12′–25°31′ N, 109°45′–117°20′ E), which includes 21 at the end of 2015, prefecture-level cities is located in southern China (Fig. 1). It covers a land area of 179,716 km^2; of that, 27.5% consists of agricultural land (including arable, orchard, grass, and other agricultural land, but not forest land) and 55% is woodland. The elevation is higher in the north and lower in the south; mountain ranges extend from east to west. The province has subtropical and tropical monsoon climates: the mean annual temperature is 21.8 °C; from north to south, there are 1500–2300 sunshine hours annually. Guangdong Province is home to several vegetation types, including tropical monsoon rain forest, subtropical monsoon evergreen broad-leaved forest, and coastal tropical mangroves.

Because of its abundant land and water resources, fine natural environment, and unique geographic position adjacent to Hong Kong and Macao, Guangdong is known for its large population, small area of cropland, and high per capita income. For example, by the end of 2015, the province had a permanent population of 108.49 million, a gross domestic product (GDP) of 7.868 trillion RMB, and per capita GDP of 72,530 RMB. However, there are great economic disparities among different areas in the province. As evident in Fig. 1(3), the province can be divided into four areas in terms of economy and terrain: the Pearl River Delta area (PRD), including Guangzhou, Shenzhen, Zhuhai, Foshan, Jiangmen, Dongguan, Zhongshan, Huizhou, and Zhaoqing; the eastern part, including Shantou, Shanwei, Chaozhou, and Jieyang; the western part, including Zhanjiang, Maoming, and Yangjiang; and the northern mountainous area, including Shaoguan, Heyuan, Meizhou, Qingyuan, and Yunfu (http://www.gdstats.gov.cn).

Based on data (http://www.gdstats.gov.cn/tjsj/gdtjnj/) from 2015 (Table 1), the PRD occupied about 30.5% of Guangdong's land area, had 54.1% of the total permanent population, accounted for 79.1% of total GDP, and had the lowest proportion of primary industry (1.79%). In contrast, the northern mountainous region occupied the largest land area (42.7%) in the province but had only 15.3% of the total permanent population and accounted for only 6.3% of the GDP. In 2015, the per capita GDP in the northern area, at 29,510 RMB, was much lower than in the PRD (106,000 RMB) and lower than for all China (49,869 RMB) (from Chinese Statistical Yearbook, http://www.stats.gov.cn/tjsj/ndsj/2016/indexch.htm).

2.2. Data

Land-use data for 1980, 1990, 1995, 2000, 2005, 2010, and 2015 were provided by the Data Center for Resources and Environmental Sciences of the Chinese Academy of Sciences (http://www.resdc.cn) in the form of Landsat images. The datasets, which comprised six primary levels and 25 secondary levels, were visually interpreted. The Data Center provided a digital elevation model, acquired from the Shuttle Radar Topography Mission. The administrative boundaries used were the most recent ones available in 2015. The Data Center also provided layers for roads, acquired from the latest navigation map in 2016. The spatial layers had a spatial resolution of 30 m and were projected on the Clarke 1866 Albers coordinate system with a false easting and false northing at zero, central meridian at 105°, and standard parallels at 25° and 47°.

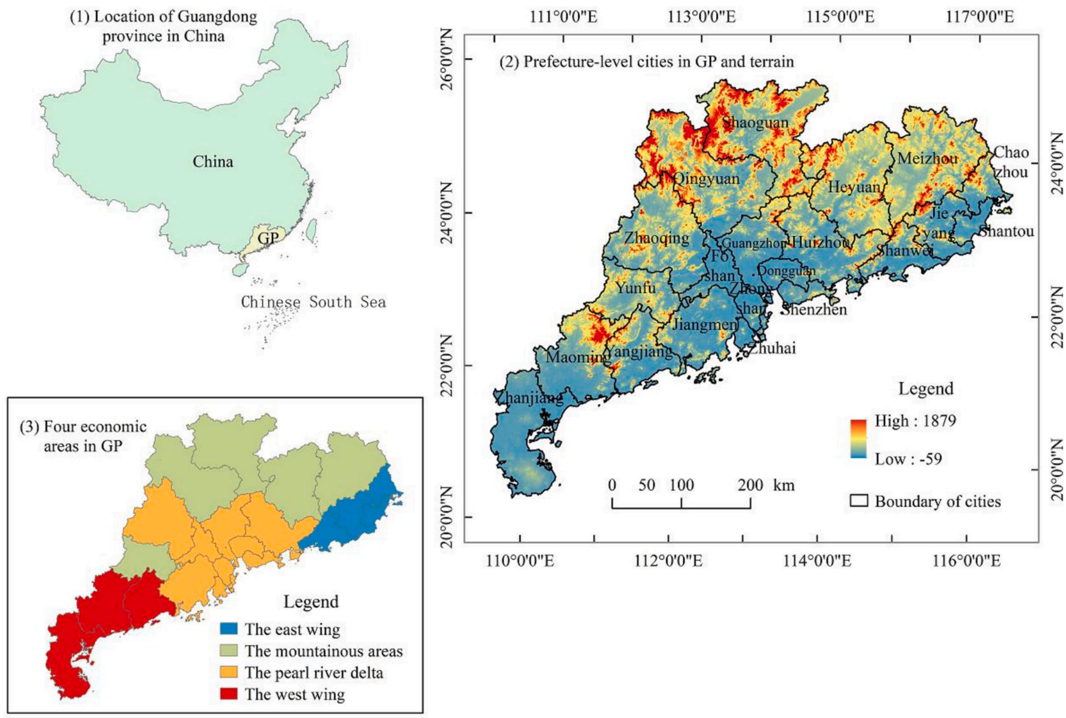

Fig. 1. Location of the study area in China and its administration. 'GD' stands for Guangdong Province.

Table 1
Land area, population and GDP of Guangdong Province in 2015.

Region	Population		GDP	Proportion of industries (%)				Urbanization Rate(%)	Land area	
	10-thousand persons	Percent (%)	100 million yuan	Percent (%)	Primary Industry	Secondary Industry	Tertiary Industry		Area (km^2)	Percent (%)
Pearl river delta	5874.28	54.1	62267.78	79.1	1.79	43.58	54.63	80.40	54763	30.5
East wing	1727.31	15.9	5430.21	6.9	8.23	53.80	37.98	59.99	15475	8.6
West wing	1583.34	14.6	6075.66	7.7	17.24	40.69	42.07	43.56	32646	18.2
Mountainous areas	1664.08	15.3	4910.84	6.2	15.80	39.54	44.67	46.71	76751	42.7

Note: All data in the table were from Guangdong Statistical Yearbook 2016.

2.3. Methods

2.3.1. Kernel density analysis

Using the rural settlement datasets and Feature to Point tool in ArcGIS, we calculated the center point of each settlement patch and created point-feature layers. We then used kernel density analysis to produce density maps so that we could explore the spatiotemporal characteristics of rural settlements. A kernel function, expressed as a bivariate probability density function, resembles a "bump" at a known point and tapers off to 0 over a defined bandwidth or window area. The kernel function and bandwidth determine the shape of the bump (Chang, 2006). The bandwidth of the kernel density tool in ArcGIS is known as the search radius and is used to determine the distance to search for sample locations. The function is calculated as follows (Chang, 2006):

$$Y(x) = \frac{1}{nh^d}\sum_{i=1}^{n} K\left(\frac{1}{h}(x - x_i)\right) \tag{1}$$

where $Y(x)$ is the estimated probability of a rural settlement (using kernel density) at spatial point x, x_i is the known point i within the search radius, $K(\ )$ is the kernel function, n is the number of known points within the search radius, and d is the data dimensionality and is equal to 2 for two-dimensional data.

2.3.2. Changing rates of rural settlement transition

We used map overlay analysis to determine the transitions in the rural settlements. The ratios of change between the areas of rural settlement land and other land-use types based on a transition matrix (Nichols et al., 2017) were measured; the transition probability was calculated for each interval as follows:

$$P\_out_{t,i} = \frac{\Delta S_{t-1,i}}{\sum_{i=1}^{n}\Delta S_{t-1,i}}, \quad P\_in_{t,i} = \frac{\Delta S_{t,i}}{\sum_{i=1}^{n}\Delta S_{t,i}} \tag{2}$$

where $P\_out_{t,i}$ indicates the area transition rate from rural settlement land to i land-use type from time t-1 to t and $P\_in_{t,i}$ is the rate of change from i land-use type to rural settlement land in the same period. $\Delta S_{t-1,i}$ is the transfer-out area of rural settlement land to i land-use type during t-1 to t, $\Delta S_{t,i}$ is the transfer-in area of rural settlement land from i land-use type, and $\sum_{i=1}^{n}\Delta S_{t-1,i}$, $\sum_{i=1}^{n}\Delta S_{t,i}$ are the total areas for rural settlement land in times t-1 and t.

2.3.3. Hot-spot analysis

We analyzed the patterns in spatial clustering in the point features layer with the spatial autocorrelation (Moran's I) tool in ArcGIS. Then, to identify statistically significant hot and cold spots of rural settlements, we created a layer of hot and cold spots using hot-spot analysis (Getis-Ord Gi*) in ArcGIS from the point features layer of rural settlements and boundaries.

2.3.4. Logistic regression

We established a logistic regression model to examine the drivers behind the changes in rural settlements (Casella and Berger, 2009). Logistic regression was used to analyze the qualitative variables. Because of the limited dataset, we focused on drivers related to the natural environment. By means of land-use datasets (binary response), we categorized land use at a particular location as either a rural or non-rural settlement; thus, we employed a binary logistic model to estimate the probability of a location being a rural settlement. The equation of the logistic regression model is as follows:

$$P = 1/(1 + \exp(-(a_0 + a_1x_1 + a_2x_2 + \ldots + a_nx_n))) \quad (3)$$

where P represents the estimated probability that there was a rural settlement somewhere in the spatial location; $x_1, x_2, \ldots, x_n$ are independent variables; a_0 is the intercept (constant); and $a_1, a_2, \ldots, a_n$ are the regression coefficients that indicate the relative effect of independent variables $x_1, x_2, \ldots, x_n$, respectively. n is the total number of independent variables ($n = 11$, as shown in Table 4). Spatial logistic regression was carried out in SPSS20 with over 80,000 random samples.

To test the significance of each independent variable in the model in equation (3), we used the Wald statistic and significance (P value). The significance of the independent variable in the model increased as the Wald value increased or the P value decreased (Yu and He, 2003).

3. Results

3.1. Changes in rural settlements

With China's reform policies, opening up of the economy, and consequent socioeconomic development, the area occupied by rural settlements grew from 4,369 km in 1980 to 4,991 km in 2000 (Fig. 2). The total area of rural settlements remained relatively stable for the 5 years from 2000 to 2005: it covered 4,959 km in 2005. After 2005, there was a period of rapid decline, and rural settlements covered only 4,223 km in 2010. By 2015, rural settlements again showed a small increase in area.

Changes in rural settlements appear in Tables 2 and 3. The transfer-out rates from rural settlement areas and transfer-in rates are shown in Tables 2 and 3, respectively. As evident in Fig. 2, the total areas of rural settlements remained relatively stable from 1980 to 2015; however, there were clear changes between 1980 and 2000. The transfer-out rates suggest that only about 64% and 64.6%, respectively, of rural settlements in 1990–1995 and 1995–2000 remained unchanged. The transfer-in rates were 61.5% in 1990–1995 and 61.1% in 1995–2000.

When land within rural settlements was abandoned, it was often first converted to high-production cropland. For example, from 1990 to 1995, 15.9% and 5.7% of the rural settlement land was converted to, respectively, paddy fields and dry farmland; from 1995 to 2000, 15.7% and 7.6%, respectively, was converted to paddy fields and dry farmland. About 6.3% and 1.8% of rural settlement land became town or other construction land types in, respectively, 1990–1995 and 1995–2000. Newly constructed rural settlements generally occupied fertile land. For example, 18.0% and 8.8% of paddy fields and 15.5% and 5.6% of dry farmland were converted to rural settlements in, respectively, 1990–1995 and 1995–2000.

Since 2000, China's rural development has entered a new phase. Of the land converted from rural settlements, the largest proportion was converted to town or other construction land. For example, 8.5%, 13.4%, and 0.6% was converted to town or other construction land in, respectively, 2000–2005, 2005–2010, and 2010–2015 (Tables 2 and 3). Only 0.3%, 5.6%, and 0.1% of rural settlement land was converted to other land-use types in, respectively, 2000–2005, 2005–2010, and 2010–2015. However, rural settlements encroached onto good farmland. New rural settlements grew by 3.9%, 2.0%, and 0.7% at the expense of paddy fields in, respectively, 2000–2005, 2005–2010, and 2010–2015. In 2000–2005, 2005–2010, and 2010–2015, respectively, a further 1.1%, 0.6%, and 0.2% of new rural settlements were on dry farmland and 0.9%, 0.6%, and 0.2% were on grassland.

3.2. Spatiotemporal patterns of rural settlement land

The distribution patterns in all the different density maps were consistent; thus, we have included only some examples of the typical kernel surfaces in Fig. 3. Across the province, there was clear spatial heterogeneity (Fig. 3). The densities of rural settlements tended to be highest in the eastern and western coastal areas; that reflects the favorable physical conditions (ample sunshine and rainfall), flat terrain, convenient location, and socioeconomic development level (SEDL) (Fig. 1(2), Fig. 4(2)).

Throughout China, coastal and plain areas have generally developed more rapidly than inland and upland areas. In Guangdong, the coastal and plain areas in the center of the province (Fig. 1(3)) have special advantages and a relatively high SEDL; thus, the overall population density is high (Fig. 4(3)), and the rural settlement density is also relatively high. However, owing to rapid urbanization, urban expansion has incorporated large amounts of agricultural land; previously agricultural populations have become non-agricultural populations. Accordingly, the central area now has a lower agricultural population and fewer rural settlements than either the eastern or western parts of the province. The rural settlement densities are also low in the northwestern mountainous region, reflecting the physical features and slower rates of socioeconomic development (Table 1, Fig. 4).

In Fig. 5, we provide two examples of the hot-spot analysis. There were clear hot and cold spots throughout the province; however, there were no obvious changes in the patterns of hot and cold spots from 1980 to 2015. The analysis showed that the area of rural settlements was highest in the western part; that was followed by the central PRD region, where there were several small hot spots. In contrast, there was only one hot spot in the eastern part that had the same size as those in the western and central parts. The maps indicated that there were more rural settlements in areas with medium-level development.

Table 2
Transfer-out rates of rural settlement areas.

	1980–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015
Rural settlement	98.5	64.0	64.6	91.3	81	99.3
Paddy fields	0.5	15.9	15.7	0	1.8	0.1
Dry farmland	0.2	5.7	7.6	0	1	0
Forest land	0.4	5.1	4.8	0.2	0.7	0
Grass land	0.2	0.9	0.7	0	0.1	/
Water body	0	2	4.7	0.1	2	0
Town and/or other construction land	0.1	6.3	1.8	8.5	13.4	0.6
Unused land	/	0	0.1	/	0	/
Sea-filled land	/	/	0	/	/	/

Note: "/" indicates almost no change.

Table 3
Transfer-in rates of rural settlement areas.

	1980–1990	1990–1995	1995–2000	2000–2005	2005–2010	2010–2015
Rural settlement	95.0	61.5	61.1	91.8	95.1	98.4
Paddy fields	3.6	18.0	15.5	3.9	2.0	0.7
Dry farmland	0.6	8.8	5.6	1.1	0.6	0.2
Forest land	0.2	5.3	5.0	0.9	0.6	0.2
Grass land	0.1	0.7	0.8	0.1	0.1	0.0
Water body	0.3	4.7	2.7	2.1	0.4	0.5
Town and/or other construction land	0.2	0.9	9.3	/	1.3	/
Unused land	/	0.1	0	/	0	0
Sea-filled land	/	/	/	/	/	0

Note: "/" indicates almost no change.

Table 4
Variables in the logistic model.

Variables		Unstandardized Coefficients	Walds	Sig./P
Constant		−4.49003298	4709.031	0.0000
Distance to railway (m)	x_1	−0.00006842	4875.584	0.0000
Distance to river (m)	x_2	0.00015531	2810.875	0.0000
Distance to highway (m)	x_3	0.00008004	2643.022	0.0000
Distance to prefectural road (m)	x_4	−0.00008541	2444.208	0.0000
Distance to county road (m)	x_5	0.00003056	1911.280	0.0000
Distance to provincial road (m)	x_6	0.00005362	1528.353	0.0000
Slope (°)	x_7	−0.08221497	841.438	0.0000
Annual precipitation (mm)	x_8	−0.00122658	325.589	0.0000
Elevation (m)	x_9	−0.00513390	145.509	0.0000
Accumulated temperature (°C)	x_{10}	0.00011217	81.847	0.0000
Distance to national road (m)	x_{11}	−0.00000028	0.036	0.8501

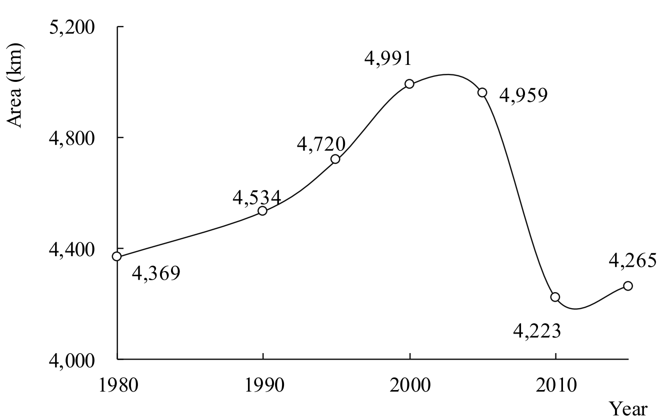

Fig. 2. Areas of rural settlements from 1980 to 2015.

3.3. Identifying factors that influence rural settlements

The output from the logistic regression analysis appears in Table 4. The analysis showed that except for distance to national roads ($P = 0.8501$, Wald value 0.036), the variables were significantly associated with the probability of rural settlements: the significance was less than 0.001 for each variable when the Wald test was applied. The Wald values (in parentheses) indicate that distance factors—including the distance to a railway (4875.584), river (2810.875), highway (2643.022), prefectural road (2444.208), county road (1911.280), and provincial road (1528.353)—were significantly associated with the probability of having a rural settlement at a certain point. Slope, annual precipitation, elevation, and accumulated temperature had Wald values of 841.438, 325.589, 145.509, and 81.847, respectively. This analysis indicates that the pattern of rural settlements was more closely related to water sources (distance to a river) and transport systems than environmental factors.

Because of the short travel times by train or highway, both railways and highways—with Wald values of 4875.584 and 2643.022, respectively—were important for rural settlements. As shown by the lower Wald values, terrain (slope and elevation) and weather conditions (precipitation and temperature) were less important than water sources and transport systems.

4. Discussion

4.1. Transitions in rural settlements and driving forces

We found that rural settlements in Guangdong Province showed a sharp increase in 1980–2000, were relatively stable in 2000–2005, and presented a rapid decrease in 2005–2010; since 2015, they have again shown a rise. This outcome is not in agreement with that reported in earlier studies (Conrad et al., 2015; Long et al., 2007, 2009), which observed expansion following accelerated industrialization. Our paradoxical finding indicates that local transitions in rural settlements are affected by policies (Long et al., 2009). Since 1978, implementation of China's open-door policy contributed greatly to the sharp rise in the number of rural settlements. Subsequently, various policies were implemented by the government in 2003 and 2004 to reduce the

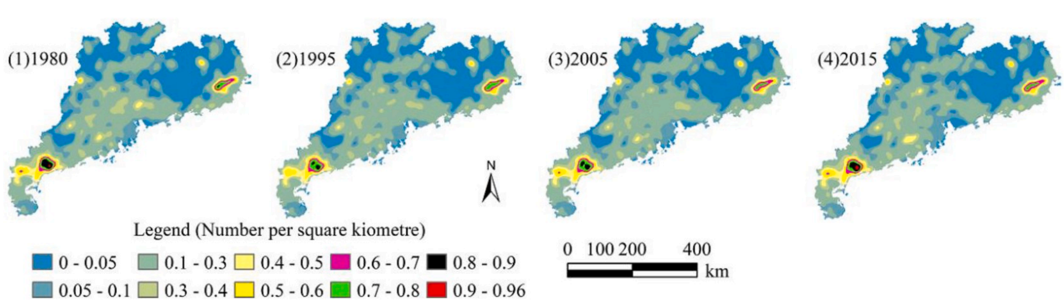

Fig. 3. Density maps of rural settlements in Guangdong Province in (1) 1980, (2) 1995, (3) 2005 and (4) 2015.

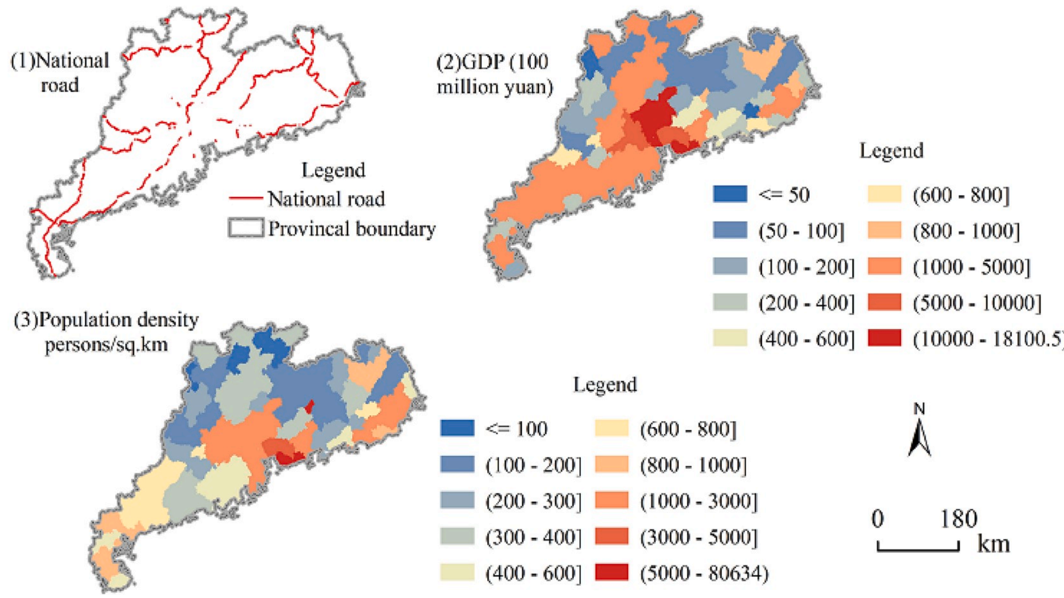

Fig. 4. (1) All national roads across Guangdong Province; (2) GDP, and (3) population density in 2015 for each city.

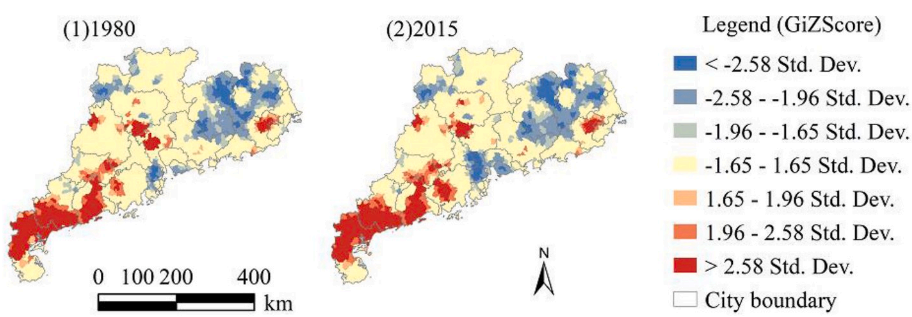

Fig. 5. Hot and cold spots of rural settlements in Guangdong Province in (1) 1980 and (2) 2015.

limitations and negative influences of urbanization on the environment. Under those policies, local governments were supposed to adopt appropriate measures to coordinate socioeconomic and environmental development. Those measures meant that the total area of rural settlements remained relatively stable from 2000 to 2005. Under the auspices of a scheme to promote village modernization (implemented under the 11th Five-Year-Plan in 2006–2010), old enterprises were transferred from villages to small towns; many scattered rural residents were aggregated in new centralized communities; and many families migrated to villages or towns. Thus, there was a period of rapid decline in rural settlements.

Policies have contributed greatly to multistage transitions in rural settlements. However, logistic regression analysis indicated that the pattern of rural settlements was more closely related to water sources (distance to a river) and transport systems than to environmental factors; that was owing to the benefits of a low-cost water supply and convenient traffic connections (Infante-Amate et al., 2016). National roads (namely, numbers 105–107, 205–207, 321, and 323–325) are sparsely distributed across the province (Fig. 4). Those roads were not, therefore, the preferred choice for residents when traveling; as shown by the large P (0.8501) and small Wald (0.036) values, they were not significantly associated with the probability of a rural settlement (Table 4).

4.2. *Implications for implementing rural revitalization strategy*

In line with initiated policies (Tian et al., 2014), there were clear turning points in the development of rural settlements. There was an early stage of expansion from 1980 to 2000, a stable stage from 2000 to 2005, a rapid decline from 2005 to 2010, and another expansion stage from 2010 to 2015. The data (Table 1) show that provincial development was highly skewed. Zheng (2015) predicted that the proportion of GDP in the mountainous areas would decrease. Our results show that government policies have had some influence on the development of rural settlements and the rural economy; however, they have also widened the discrepancy between urban and rural areas. In 2017, the Chinese government promoted a strategy for rural revitalization (Zhong, 2018); the government of Guangdong Province has also produced a comprehensive development plan.

4.2.1. *Concerns about developing a rural planning system*

There is a saying in China that if you want to develop the economy, you should first make a plan. Until 2008, China implemented a dual planning system that covered both urban and rural areas, but where rural planning was accorded less importance. The situation has changed since the government introduced the Urban and Rural Planning Law in 2008; however, comprehensive, systematic plans for rural areas remain poorly developed (He et al., 2017). Two main issues need to be resolved if the situation is to be improved.

First, local cultures should be emphasized. For more than 1000 years, the Chinese have formed unique rural communities and lived in harmony with nature. The country's distinctive and varied cultural heritage is still evident in rural areas. However, the results of this paper indicate that considerable amount of land previously occupied by rural settlements has become used for towns or other construction purposes (Table 2); that development was particularly marked in 2000–2010. Many traditional rural settlements have disappeared from many regions (Cohen and Sofer, 2017); others have undergone redevelopment, and in rural Guangzhou modern Louvre-gallery-style buildings replaced traditional ones (Sun, 2017). Therefore, in future rural planning, cultural heritage assets (such as traditional architecture and historic rural settlements) should be accorded high value.

Second, there is concern about a top-down approach being adopted when implementing rural development plans and programs. The current top-down management approach means that exogenous forces are considered more important than endogenous ones. Rural residents are seldom involved in local planning; thus, they are detached from planning related to the development of their environment. This means that when plans are implemented, they have a short-term positive effect; however, over the long term, the countryside gradually declines and loses its original beauty and unique character (Zhang, 2014).

4.2.2. *Strengthening bonds among different economic areas*

Rural plans and comprehensive development plans should coexist to reduce regional differences, offering opportunities both for economic development in coastal areas and rural revitalization. We suggest the following strategies for Guangdong Province:

First, it is necessary to protect ecologically pristine areas in the northern mountains that fall within the green-shelter and ecological protection areas designated under the Ecological Red Line policy of China's Ministry of Environmental Protection (Bai et al., 2018). It is important to respect robust ecological principles when developing rural areas.

Second, in the context of a comprehensive development plan and because of geographic connections to the South China Sea, Hong Kong, and Macau, we believe that ongoing urban and rural development and urban-rural integration are inevitable within the PRD and eastern and western parts of Guangdong.

Third, it is necessary to improve the communication regions within Guangdong. The PRD is one of China's most developed regions, but other areas of Guangdong are relatively poor; for example, the economy in northern Guangdong is far below the national average. The socioeconomic gaps reflect the lack of motivational mechanisms between the PRD and other areas of Guangdong Province (Cui and Zhang, 2015).

4.2.3. *Emphasizing local cultural heritage*

Transfer-out and transfer-in rates of rural settlements show that there was an obvious transition between rural settlements and other land uses from 1980 to 2015 (Tables 2 and 3). This could be a cause for concern. As reported above, there are many notable rural settlements in Guangdong Province that are great repositories of traditional Chinese culture. However, during China's urbanization, some of those traditional rural settlements have disappeared (Zhang, 2018) or been replaced by modern Louvre gallery-style buildings (Sun, 2017). Similar cases have been reported in other studies: the cave dwellings in Shanxi Province have disappeared (Yang and Han, 2011): thatched huts in Hainan Province have been rebuilt with concrete and steel (Sun, 2017). Preservation of the local cultural heritage in rural settlements faces many challenges in Guangdong Province and throughout China. As a country with a history dating back almost 5000 years, China has rich diversity. All Chinese citizens should feel duty bound to protect and hand on the nation's cultural heritage. Since the 19th National Congress of the CPC in 2017, Chinese have recognized the importance of implementing a strategy for rural revitalization. It is now the time to promote rural development while protecting traditional rural settlements and emphasizing local cultural heritage, which has been frequently ignored in recent decades.

5. Conclusions

In this study, we analyzed how rural settlements changed in Guangdong Province from 1980 to 2015 and considered what drove these changes. Over the past 35 years, there have been clear stages in the development of rural settlements regarding their area: increase (1980–2000); stability (2000–2005); decline (2000–2010); and increase (2010–2015). Those stages have been accompanied by frequent migration of rural populations from one place to another; the cause was considerable spatial variability in socioeconomic conditions across the province.

Favorable physical conditions and moderate levels of socioeconomic development always benefit higher densities of rural settlements. Thus, the coastal and plain areas in central Guangdong Province—having favorable physical conditions (ample sunshine and rainfall, flat terrain, convenient location) and higher SEDL—have the highest densities of rural settlement. The central area now has a lower agricultural population and fewer rural settlements than the eastern and western parts of the province; that is because large areas of agricultural land were absorbed by urban expansion, and previously agricultural populations became non-agricultural populations. Rural settlement densities are also low in the northwestern mountainous region, reflecting the physical features and slower rates of socioeconomic development there.

Government policies played a role in the changes; however, access to water sources and transport systems was more important to transitions in rural settlement. To implement a rural revitalization strategy in Guangdong Province, the unique features and complexity of the countryside should be considered. Plans for rural Guangdong should place a high value on the southern Cantonese culture and its heritage assets; they should also address the isolation that currently exists among regions.

Declaration of competing interest

The authors declare no conflicts of interest.

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