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Spatio-temporal Differentiation of Residential Land for Coastal Town: A Case Study of Dalian Jinshitan

YANG Jun[1,2], SUN Jing[1], ZHAO Hongdan[1], XI Jianchao[2], LI Xueming[1]

(1. *Liaoning Key Laboratory of Physical Geography and Geomatics, Liaoning Normal University, Dalian* 116029, *China*; 2. *Key Laboratory of Land Surface Pattern and Simulation, Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing* 100101, *China*)

Abstract: Based on SPOT5 satellite remote sensing images and land use data in five time phases covering the period 1988–2012, the distribution characteristics, spatial differentiation processes, and driving mechanisms affecting the residential land of the Jinshitan Tourist Resort were studied. The work included a combination of GIS technology, adoption of the differentiation index D, and the multi-group differentiation-measure model D (m). The results provided a basis for the following conclusions: 1) From 1988 to 2012, the degree of differentiation of the rural residential land first decreased, and then increased. The general residential, commercial residential and garden-house land-types all showed declining trends, of which the garden-house type presented the most intense volatility. 2) The overall background of the traditional residential land type was gradually replaced by a new residential land type, and the total area of residential land increased year by year, significantly improving the overall residential conditions. The areas of the new residential land type showed growth, and were increasingly widely distributed in the coastal tourist resorts, transportation corridors, and scenic areas. 3) Government policy, social differentiation, market mechanisms, and individual choices (along with other factors) were mutually promoted, although still restrained. However, all of these factors interacted to constrain the developmental direction and the processes affecting tourism real estate in the Dalian Jinshitan Tourist Resort.

Keywords: residential space differentiation; differentiation degree; residential conditions; driving mechanism; Dalian Jinshitan

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1 Introduction

In the past few decades, social change and economic development have resulted in deepening social divisions within the labor force. The consequential great differences in resident income have led to social class differentiation and formation of a spatial differentiation phenomenon (Iceland *et al*., 2005; Schnell *et al*., 2015). Urban residential space is an important embodiment of urban physical space, social space, and economic progress (Wu *et al*., 2014; Delmelle, 2015), within which the differentiation phenomenon is increasingly obvious.

Policy guidance, market regulation, and local adjustments in the psychology affecting the choices of individual residences, all induce joint-interactions that affect the spatialization process based on social order (level) (Wu *et al.*, 2002). The differentiation in urban residential space is a reflection of the constant development of urban space from simple to complex, emphasizing the geographical distribution of human-based living spaces within a city.

The earliest international study on differentiation of urban residential space is the Chicago School study presented by Park, for the purpose of describing the spa-

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tial distribution of social groups within a city (Park and Iceland, 2011). The classic theoretic models of urban residential space were proposed for use in this study, namely the Burgess Concentric Zone Model (Zhang and Chai, 2014), the Sector Model, and the Ullman Multiple Nuclei Model. One consequence of the Chicago School study was the later formation of the Urban Social Culture School to study the issues of urban residential space, from both social and cultural perspectives (Rosen and Walks, 2013). It was also intended to explore and explain the formation of urban residential spatial distribution under realistic conditions. Represented by Shevky, the aim of the Positivism School was to adopt the empirical research on the urban spatial differentiation from theory (Dupont, 2004), laying a solid foundation for empirical research on future spatial differentiation. After a long period of development, research methods and means (Kityuttachai *et al.*, 2013) to determine differentiation in urban residential spaces abroad have become relatively mature. Domestic research on the differentiation in residential space began in the 1980s. As the main content of urban geography, the research on spatial differentiation was a combination of calculation and empirical research from the start. Many scholars have carried out research on social areas of Beijing (Gu and Kesteloot, 1997), Shanghai (Li and Wu, 2006), Guangzhou (Wei *et al.*, 2007), and other places. The findings in these studies indicate that the main factors in domestic social-space differentiation (e.g., degree of population intension, family structure, technological and cultural level, traffic accessibility), are quite different from the factors dominant in other parts of the world. Since 1994, reform of the town housing system has deepened constantly, the relation between residential space differentiation and urban planning. This has prompted research on residential-space differentiation separate from the study on social-space differentiation (Wu *et al.*, 2014). Survey research was conducted on the attribute characteristics of 1075 new-built urban residential communities in Nanjing during 1998–2008 (Song *et al.*, 2010). Taking the differentiation phenomenon of urban residential space as an example, Java-Swarm simulation technology (Tao *et al.*, 2007) was used to simulate the process of an urban system developing from disorder to order. The multi-agent-differentiation model of residential space revealed generation of a residential-agent-aggregation phenomenon,

and its influence on housing values, that was used to compare the influences of different resident income situations on residential-space differentiation. Research methods have shown frequent innovation: qualitative analysis, quantitative analysis (Sun and Wang, 2008) and factor-based ecological analysis (Xu *et al.*, 1989) in the initial phase. This was followed by empirical analysis (Yin *et al.*, 2011), GIS software analysis (Liu and Zhang 2014), model analysis and simulation, and comparative analysis. The scale of recent research (Wu *et al.*, 2013) not only includes macro-scale (large area) studies, but also specific analysis at medium and micro scales. Research perspectives are diverse, including such as the type of housing, housing price (Wang *et al.*, 2013), choice of residence location, types of residential land (Liao *et al.*, 2012), land price (Hu *et al.*, 2012), Residential land expansion (Chu *et al.*, 2007; Peng and Cheng, 2007), per capita resident income and population structure.

The directions of the earliest research on tourist resorts by experts and scholars at home and abroad, mainly include market characteristics, development, and protection (Palmer and Mathel, 2010), tourism management (Xie *et al.*, 2013), resource protection (Huang, 2001), development potential (Trukhachev, 2015), and development mode (Agarwal, 2012; Doiron and Weissenberger, 2014) of resorts. The emergence and spread of the modern urbanization phenomenon lead to the rapid development of coastal tourist resorts (Burak *et al.*, 2004; Zhu and Jia, 2006). Due to beautiful natural environment and the development of urbanization facilities in coastal tourist resort areas, coastal tourism occupies an advantageous niche in the tourism industry (Onofri and Nunes, 2013). The business of tourism real estate (Van Noorloos, 2013; Yang *et al.*, 2016) thrives as a consequence of a booming tourism industry, and is characterized by development that is distinct from that of general real estate. Those in the tourism real estate business are required to balance between economic and environmental benefits (Liu *et al.*, 2014; Long *et al.*, 2014; Levine and Feinholz, 2015). In order to orient development of leisure-tourism real estate, such development should be combined with natural context, geographical location, and real estate requirements that accommodate important reflections of the effects of tourism (Salazar and Zhang, 2013). Real estate projects that rely on development of coastal tourism resources are an

important part of the overall real estate project. This is another important manifestation of booming tourism in recent years. Urbanization in the tourist resort areas promotes the formation of residential-space differentiation. As a result, the characteristics and trends affecting residential-space differentiation in tourist resorts embody a tourism urbanization effect that reflects the speed and deepening degree of economic development in this tourist resort, at least to a certain extent (Pons and Rullan, 2014; Stylidis *et al.*, 2014; Xi *et al.*, 2014).

In this paper, a mature research framework for urban residential-space differentiation is applied to the tourist resort as a special function area to calculate the spatial differentiation intensities of various residential lands in this area. By adopting a combination of qualitative and quantitative methods, and by applying GIS technology, we aimed to measure accurately the overall situation of residential-land space differentiation in Jinshitan Tourist Resort. This involved display and analysis of the process, characteristics, and driving mechanisms of residential-space differentiation in this area (Qian *et al.*, 2012). The results would provide a reference to assist in achieving the optimal allocation of resources, and to promote healthy and steady development of domestic tourist resorts.

2 Materials and Methods

2.1 Study area

Jinshitan Tourist Resort is a typical national 5A tourist scenic spot located along the coast of the Yellow Sea, at the southern tip of Liaodong Peninsula and the tip of Dalian. It has a coastline of 30 km, a sea area of 58 km^2, and land area of 62 km^2. Since 25 January 2005, the official name of this resort has been Jinshitan Subdistrict. It includes the seven administrative villages of Manjiatan, Miaoshang, Chenjia, Shizijie, Longshan, Putaogou, and Hezui (Fig. 1).

2.2 Data sources and processing

Raw data for this paper were sourced from remote-sensing images and land-use data in five time phases covering 1988 to 2012 (1988, 1996, 2003, 2007, and 2012; Table 1), of which the land-use types mainly refer to the National Land Use Classification Standard of the Ministry of Construction (GB50137-2011) implemented since 1 January 2012. Considering the actual development of the Jinshitan Tourist Resort, the types of residential land in this area can be divided into the following four categories: low-rise residences with favorable environment and complete layout (R1), multi-story and
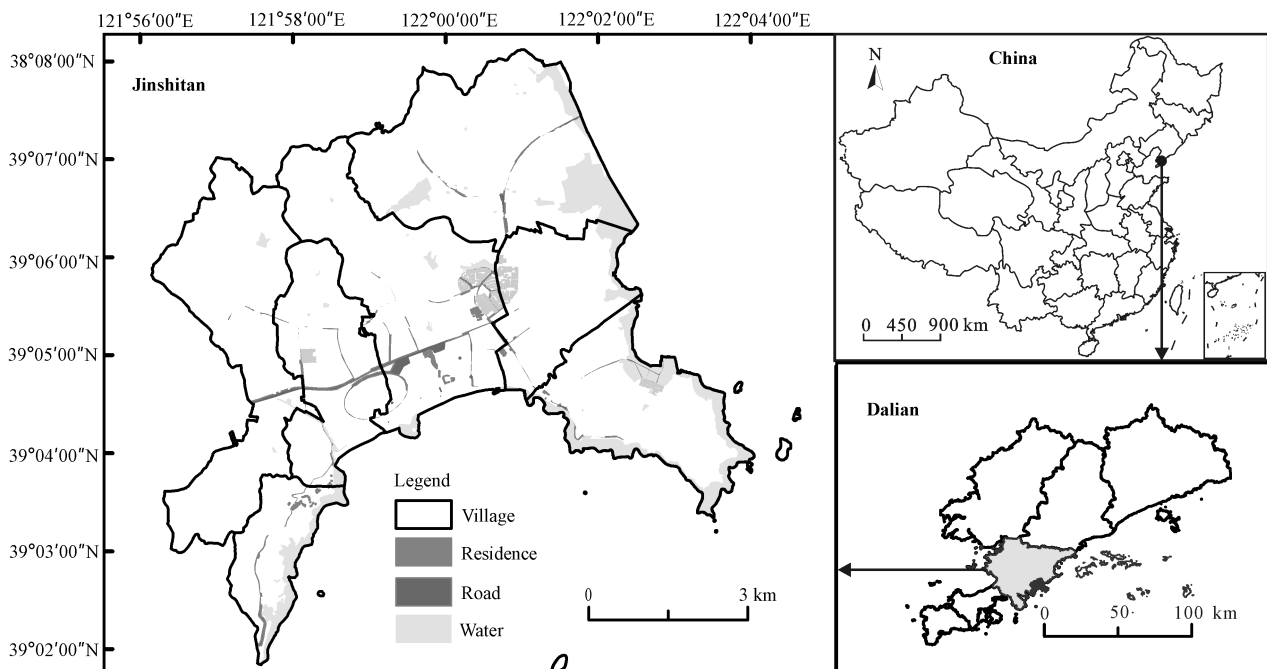

Fig. 1 Location of study area

Table 1 Data sources and description

Time	Data name	Data attributes	Data sources
1988	Land use data	Scale 1 : 10 000	Dalian Land Resources and Housing Bureau
1996	Land use data	Scale 1 : 10 000	Dalian Land Resources and Housing Bureau
2003	Land use data	Scale 1 : 10 000	Remote sensing interpretation
	SPOT5	Resolution: 2.5 m	National Marine Environmental Monitoring Center
2007	Land use data	Scale 1 : 10 000	Remote sensing interpretation
	SPOT5	Resolution: 2.5 m	National Marine Environmental Monitoring Center
2012	Land use data	Scale 1 : 10 000	Remote sensing interpretation
	SPOT5	Resolution: 2.5 m	National Marine Environmental Monitoring Center

high-rise residences with better environment (R2), multi-story residences with poorer environment (R3), and rural residences (E6).

Ten days of social investigation were carried out in the Jinshitan Tourist Resort in late November 2014 by the author. The main content of the survey was a collection of relevant information about the various types of residence present, including government policies and regulations affecting them, the residential architectural style, average price, peripheral facilities, sold ratio and actual occupancy rate, types of residents, and reason for purchase (Table 2). The photographs of the various types of residences in Table 3 come from this survey.

According to the overall residential situation in Dalian Jinshitan Tourist Resort during the study interval, in combination with National Land Use Classification Standard (GB50137, 2011) of the Ministry of Construction, the residential land in the study area was divided into four categories: garden houses, commercial residences, general residences, and rural residences (Table 3).

2.3   Research methods

The purchase of different classes of residences can reflect the gap in the purchasing ability of buyers, literally showing that the residents with different income levels are compelled by the residential market to separate into different spatial ranges. Based on related research, it is assumed that the coverage of different classes of residence reflects the inhabitation by different types of residents. The differentiation index (*D*) and multiple-group differentiation index model *D* (m) were used to calculate the intensity index of the residential-space differentiation.

In 1955, the differentiation Index *D* (Index of Dissimilarity) was widely used in the study of residential space differentiation, characterized by a strong representative, of which the role was to measure the differentiation intensity of a certain portion of residential land (Duncan and Duncan, 1955). Here, the value of *D* ranged between 0 and 1, of which 0 denotes no differentiation, while 1 denotes absolute differentiation. The greater the value of *D* is, the larger the degree of differentiation will be. The differentiation degree index is considered a kind of calculation method in sociology, and is calculated as follows:

$$D = \frac{1}{2}\sum_{i=1}^{n}\left|X_i - Y_i\right| \qquad (1)$$

where *D* is the differentiation index of all kinds of residential land; X_i is the percentage of the coverage of a certain kind of residential land accounting for total coverage of similar residential land in the survey area, *i* is

Table 2   List of survey data

Survey content	General residence	Commercial residence	Garden house
Sold ratio	96%	47%	98%
Actual occupancy rate	92%	28%	35%
Supporting facilities satisfaction rate	51%	43%	82%
Average price (yuan (RMB)/square meters)	4500	8000	13 000
Residence district types	Semi-gated community	Gated community	Gated community
Main types of resident	Local residents	Migrant workers	High earners
Main purpose of purchase	Demolition resettlement	Work required	Second residence

Table 3 Land-use classification system of residential land of study area

Residential photo	Instruction
	E6 Rural residential land **Land type**: Rural residence **Remote sensing interpretation**: Rural residence
	R3 Third class residential land **Land type**: General residence **Remote sensing interpretation**: Multi-story residence with poor living conditions.
	R2 Second class residential land **Land type**: Commercial residence **Remote sensing interpretation**: Multi-story residence with better environment.
	R1 First class residential land **Land type**: Garden house **Remote sensing interpretation**: Garden house

the spatial unit; Y_i is the percentage of coverage of other residential land except this type of residential land accounting for total coverage of other residential land in the survey area, i is the spatial unit; and n is the number of spatial units in the study area.

The multi-group differentiation index model $D (m)$ is calculated using Equation (2–3). The numerical range and significance of $D (m)$ are the same as for D. $D (m)$ is used to calculate the degree of total differentiation of residential space in the study area.

$$D (m) = \frac{1}{2} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \left| N_{ij} - E_{ij} \right|}{\sum_{j=1}^{n} N P_j (1 - P_{ij})} \quad (2)$$

$$E_{ij} = \frac{N_i N_j}{N} \quad (3)$$

where i is the spatial unit; N_{ij} is the coverage of type-j residential land in a space unit i; N_i is the total coverage of residential land in space unit i ; N_j is the total coverage of type-j residential land in the study area; N is the total coverage of residential land in the study area; P_j is the percentage of the coverage of type-j residential land in the study are a accounting for the total coverage of residential land, i.e., $P_j = N_i / N$. E_{ij} is a intermediate variable; n is the number of patches of all kinds of residential land.

2.4   Process for calculation of differentiation degree

(1) The selection of a research unit of space in China, the basic spatial statistics unit used in census data (i.e., street or town), is taken as the research unit by many scholars. In this paper, according to the actual conditions in Jinshitan Tourist Resort, the administrative village was taken as the basic spatial research unit, and the designation of administrative villages at different times was determined by extracting land use data for this period.

(2) Regarding the calculation of indices, in ArcGIS, all kinds of residential land data in the five time phases from 1988 to 2012 were superimposed with the data of administrative villages in the year of analysis, so as to calculate the coverage of all kinds of residential land in each administrative village of the Jinshitan Tourist Resort. This also allowed us to determine the differentiation index model D and $D (M)$ (variable values were taken from the coverage of all kinds of residential land). At the same time, we were able to calculate the area and the proportion of each type of residence.

3   Results

3.1   Differentiation process of residential land

(1) Garden house (R1)

The residential type called ′garden house′ appeared in 1996, and then gradually spread. In 2003, the distribution trend (Table 4) can be seen in the differentiation degree of 0.65: a state of severe isolation. The degree of differentiation of residential space in 2007 and 2012 was 0.26 and 0.06, respectively. The differentiation degree of high-grade residential space had decreased.

(2) Commercial residence (R2)

Since its appearance, the land type called ′commercial residence′ had a degree of differentiation ranging from 0.47 to 0.31. This indicated a moderate degree of isolation, with a tendency for it to decrease year by year (Table 4).

(3) General residence (R3)

From 1996 to the present, the differentiation intensity of general residences gradually decreased from 0.54 to 0.25, showing a gradually weakening trend of differentiation (Table 4).

(4) Rural residence (E6)

In 1988–2003, the area devoted to ′rural residence′

began to diminish, but the remaining area of rural residence still occupied the largest proportion of the total residential area. However, its distribution became more compact, and its degree of differentiation declined from the original 0.51 to 0.19. In 2007–2012, the trend of decrease in rural residence became more apparent as the distribution became increasingly disconnected and the degree of differentiation began a gradual increase to 0.92 in 2012 (Table 4).

3.2 Distribution characteristics of residential land

(1) Since the 1990s, preliminary planning for development has been implemented. The amount of rural residence was slightly reduced, but there appeared successively a small amount of general residence and then commercial residence. The distribution of general and commercial residences was scattered, as the amount of residential coverage exhibited a growth trend.

(2) From 1996 to 2003, residential land was dominated by rural residences, and supplemented by garden house, commercial residence, and general residence types. The proportional coverage of all kinds of residence was rural residence > general residence > garden house > commercial residence (Fig. 2).

(3) From 2003 to 2007, the transformation of Jinshitan Tourist Resort was basically completed. The area devoted to garden houses significantly increased (Fig. 3). The areas of commercial residence and general residence increased some, but their varied distribution made them inconspicuous in space. The area of rural residence rapidly declined. Overall, the total residential area in the study region increased.

(4) From 2007 to 2012, the rural residence land in Jinshitan Tourist Resort was quickly reduced, while the area of garden houses increased rapidly in all seven villages. The area in which garden houses were distributed

increased most prominently, while the land type distribution of commercial residences and general residences was in a steady state (Fig. 3).

3.3 Mechanism driving spatial differentiation of residential land

The distribution and development of existing residence is the most intuitive form of residential space differentiation in Jinshitan Tourist Resort. Combining the development of the actual process and related field survey data, it is possible to draw the following conclusions.

(1) In the initial stage (1992–2003), Jinshitan Tourist Resort was a former national scenic area, of which scenic resources were protected by the government, and no development allowed. In 1992, it was established as a national tourist resort, indicating the beginning of steps toward tourism development to promote the residential industry. Specified in the management rules of Jinshitan Tourist Resort, the development and management of hotels, villas, entertainment, sightseeing, and other such projects are encouraged. General residences, commercial residences, and garden houses appear to improve and diversify the residential potential. Therefore, mid-high-grade villas and garden houses inevitably appeared. The commercial residences were only generated

Table 4　Indices of various residential land variables by D and D(m): 1988 to 2012

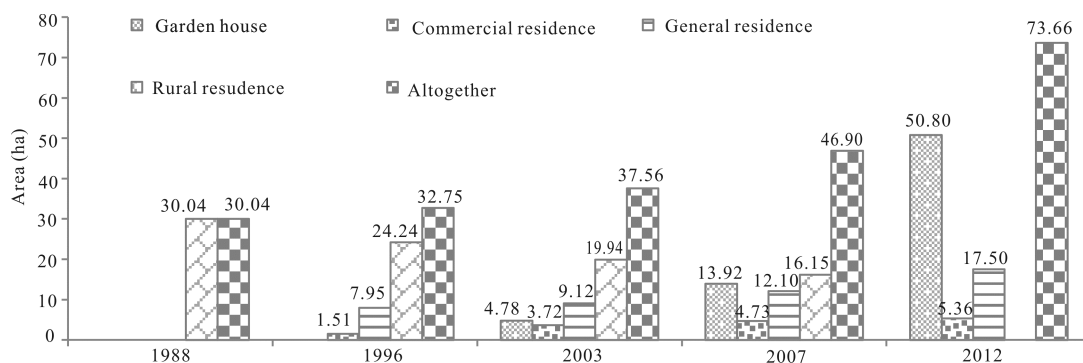| Category	1989	1996	2003	2007	2012
Rural residence	0.51	0.50	0.19	0.24	0.92
General residence	/	0.54	0.48	0.36	0.25
Commercial residence	/	0.47	0.44	0.34	0.31
Garden house	/	/	0.65	0.26	0.06
All	0.51	0.45	0.35	0.28	0.18

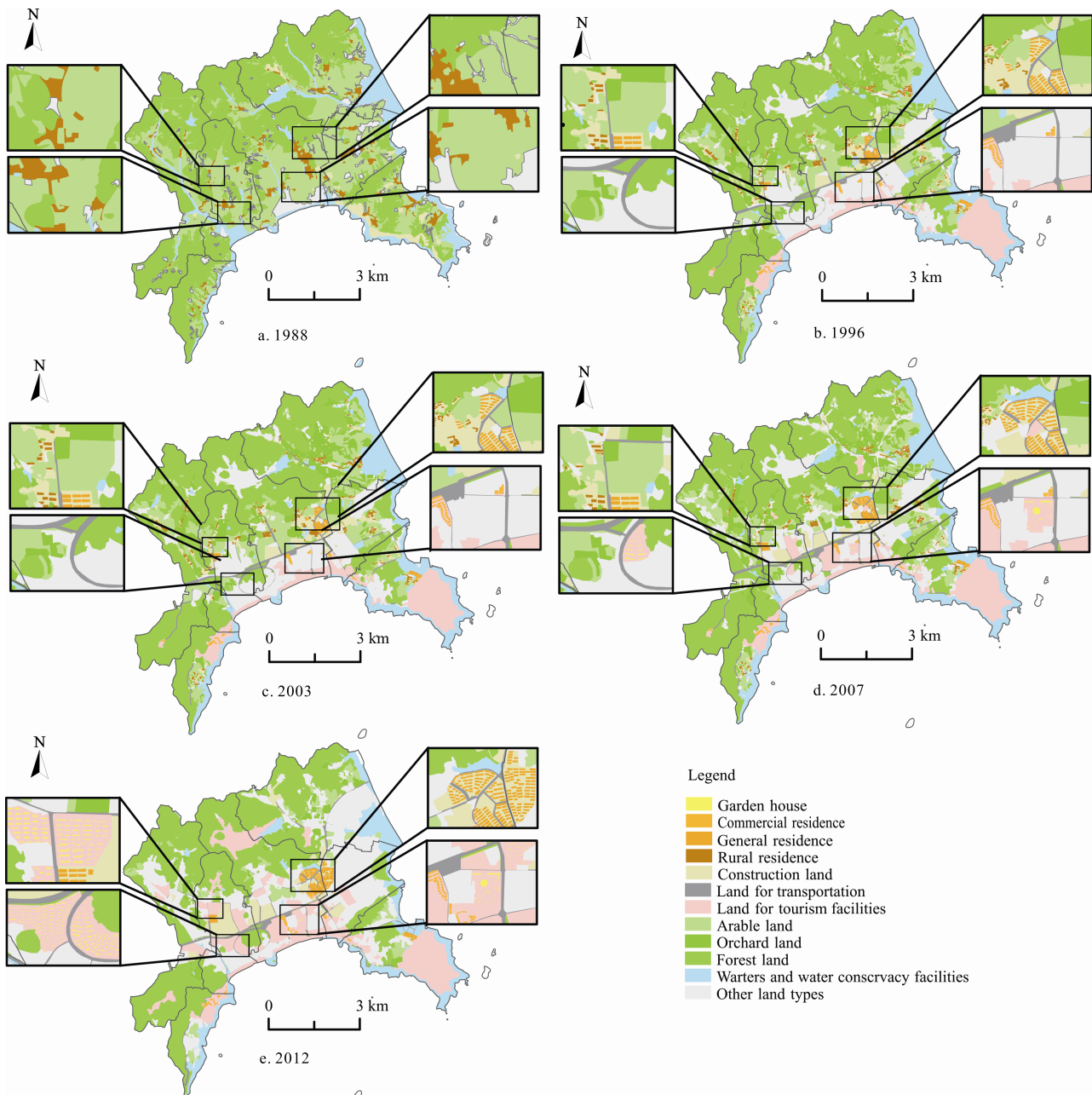Fig. 2　Residential land area of each type 1988–2012

Fig. 3 Distribution of residential land in Jinshitan: 1988 to 2012

to meet the requirements of migrants from other cities, and in such ways as to use the minimum area possible. The general residences were mostly resettlement residential areas due to the emphasis on development of tourism projects. In the beginning stage of residential construction in Jinshitan Tourist Resort, the regulatory power of governmental decision-making played a huge role (Long *et al*., 2009). Rural residences reduced in area, but remained the type with the widest distribution in the seven villages of the study area. The spatial dis-

tribution was less concentrated than before, so the differentiation degree rose.

(2) During the stage of steady development (2003– 2007), the residential industry entered a period of development at a relatively constant rate. Along with the gradually improving construction of infrastructure, and deepening development of tourism projects, the distribution of residential land was also constantly changing. For many buyers who were strongly independent, the main reference factors included convenient transporta-

tion, perfect infrastructure, and a beautiful living environment. In order to meet the market demand, commodities are 'tagged' in residential construction by developers, so as to attract buyers with different values, and the grade of residential districts becomes a status symbol. Social people in pursuit of a high-level spiritual life, not only want to own a high-quality first residence, but also want to have a second residence with beautiful scenery, pleasant climate, and a location far from the hustle and bustle of the city, for relaxation. Garden house residences spread along the coastline where beautiful scenery and convenient transportation existed, making the spatial distribution relatively concentrated, so the degree of differentiation decreased. The residential selection behavior at this stage played an important role in promoting the development of the residential industry in Jinshitan Tourist Resort.

(3) In the burgeoning stage (2007–2012), the residential industry in Jinshitan Tourist Resort moved into a phase of rapid ascension. The trend of decrease in rural residence became more apparent as the distribution became increasingly disconnected and the degree of differentiation increased to 0.92. The development of the residential industry here included a time lag attributable to the development of the regional tourism industry. The inherent advantages of the tourist resort were seamlessly grafted onto the demand for development by the real estate industry. The investment in real estate of the tourist resort provided an exuberant vitality that created a

new format for the tourism-real-estate industry. Jinshitan Tourist Resort has now attracted a large amount of commercial real estate to promote the common development of both real estate and tourism, as well as to drive the rapid rise of the tourism-residential industry in the tourist resort. Market mechanisms played a guiding role in the development of this industry.

4 Discussion

Throughout the study period, the differentiation intensities of all residences decreased from 0.51 to 0.18 within a reasonable range. The spatial differentiation of residential land in Jinshitan Tourist Resort resulted from the combined action of a variety of factors. In its role as driving mechanism, government regulation became the leading force for spatial differentiation of residential land, not only guiding the occurrence of the spatial differentiation phenomenon, but also restricting the development of the phenomenon, to ensure that the degree of residential differentiation changed within a reasonable range. The reform of land use and the real estate market were the dominant forces for spatial differentiation of residential land. Due to the existence of class division and the solidification phenomenon, different residential prices were another of the causes for spatial differentiation of residential land. The preference of residents for independence and provide neither good location nor complete support facilities, and add to their lack of
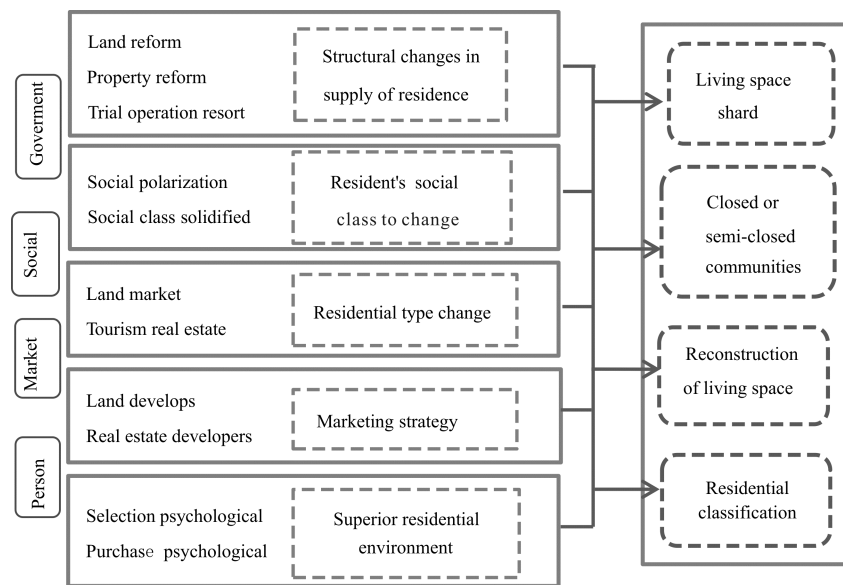

Fig. 4 Process of residential differentiation and driving mechanism

advantages a higher price. Third, the surrounding infrastructure for general residence is imperfect. General residences in Jinshitan Tourist Resort are mostly intended for resettlement communities displaced by demolition. A large number of local residents ar the behavior of residents play a role in promoting the isolation of residential spaces. The above factors were both mutually promoted and restricted to achieve development of tourism real estate in Jinshitan Tourist Resort.

There are still some unreasonable phenomena affecting the development of residence in Jinshitan Tourist Resort. First, the vacancy rate of garden houses is high. The proportion of garden houses is inconsistent with the actual income levels of local residents in Jinshitan Tourist Resort. Among the garden houses sold, only a few are purchased by the local residents, the garden houses that fail to sell can only be rented during the peak tourism seasons. Second, the development of commercial residence is lacking. Regarding commercial residence, migrant workers are the intended buyers, but the layouts are unreasonable for them. Typically, they e concentrated there. However, the peripheral facilities are typically unable to satisfy the needs of a large number of local residents. Some recommendations were made applicable to these questions: moderate exploitation, strengthen public services supporting general residential and commercial construction, slow down the speed of garden house construction, and further improve the living conditions of local permanent residents.

Based on the areas of residential land, the spatial differentiation degree of residential land can be calculated. These results are quite different from the differentiation degree of residential groups. Moreover, the kinds of residential spaces available are unable to reflect completely and precisely the living conditions of residents, nor do the residential land types fully exhibit the relation between real estate and ownership. In this paper, the conclusions drawn indirectly reflect the spatial differentiation effect and the mechanism driving the evolution of residential land.

5 Conclusions

In this study, based on multi-time-series land use and remote sensing data, in combination with on-the-spot investigation, reliable information was obtained to measure and analyze the differentiation of residential

space and the change of residence distribution in Jinshitan Tourist Resort. The following conclusions were drawn.

(1) From 1988 to 2012, the differentiation intensities of all residences decreased from 0.51 to 0.18. The degree of differentiation of the rural residential land first decreased, and then increased. The new residential land type showed declining trends, of which the garden-house type presented the most intense rise.

(2) The overall background of the traditional residential land type was gradually replaced by a new residential land type, and the total area of residential land increased year by year, significantly improving the overall residential conditions. The areas of the new residential land type garden house, commercial residential, and general residential land types showed growth. Garden house were increasingly widespread and locations were advantageous for environment and transportation.

(3) Government policy, social differentiation, market mechanisms, and individual choices (along with other factors) were mutually promoted, although still restrained. However, all of these factors interacted to constrain the developmental direction and the processes affecting tourism real estate in the Dalian Jinshitan Tourist Resort. We propose rational planning of real estate development, improve the living conditions of local permanent residents further.

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