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Study on Urban Regeneration Decision Making Map: A Case Study of the Core Cities of Pearl River Delta in China

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Abstract: In the urban stock development stage, it is essential to clarify urban regeneration characteristics, market maturity, urban regeneration potential, and development direction of objective cities for enterprises. However, previous studies lack concrete analysis for the urban regeneration system and potential, particularly with respect to quantitative research. This study evaluated the urban regeneration decision making map of the core cities of the Pearl River Delta in China (Shenzhen, Guangzhou, Zhuhai, and Dongguan), including system analysis and potential space evaluation. For the system analysis, through the horizontal comparison of the four target cities' regeneration system based on the sustainability of local policies, it was found that Shenzhen has the highest degree of perfection of urban regeneration system, followed by Guangzhou, Zhuhai, and Dongguan. Especially in the three aspects of protecting public interests, reserving industrial development space, and urban sustainable development, Shenzhen has formulated a series of supporting urban renewal laws and regulations, with the most standardized urban renewal management and the most mature urban renewal market. For the potential space evaluation, the spatial factors affecting urban regeneration potential were selected for the superposition analysis to obtain the distribution and data characteristics of the target cities' regeneration potential with the Analytic Hierarchy Process. It was found that Dongguan has the highest proportion of high potential regeneration land, accounting for 29.4%, while Shenzhen has the lowest proportion of high potential regeneration land. Regarding the four objective cities, it is more difficult to carry out urban regeneration project in Shenzhen and Guangzhou due to complex control conditions and earlier projects' accomplishment. The system of Zhuhai and Dongguan needs to be further adjusted in practice and there is a relatively more flexible space for these two cities. The current land development intensity in Dongguan far exceeds that in Zhuhai, and the demand for its urban renewal is more urgent. Therefore, this study suggests that Dongguan's urban regeneration market should become the focus of enterprises.

Keywords: Urban Regeneration, Decision Making Map, System Analysis, Potential Space Evaluation

1. Introduction

With the continuous advancement of urban construction in China, most cities have gradually entered the stage of stock development. The regeneration of urban interior land is one of the important and essential issues of urbanization in China [1, 2]. Through the stock development, reactivating the development power of cities, including the redevelopment of underused and abandoned lands, remains one of the greatest challenges for the developers [3]. As an essential developer who commits to urban regeneration, enterprises also need to make corresponding decision changes, from the perspective of "incremental development" to "stock development".

China Construction Eighth Engineering Division Co. LTD (CCEED) has been engaged in China's urban construction for nearly 70 years, and has made significant contributions to China's urbanization. Currently, under the background of the change of development mode, CCEED is also adjusting its own perspective to formulate new development strategies for the proposition of urban regeneration. Formulation of the strategies needs detailed and scientific theory and data support. Differences in different stages of urban development,

urban regeneration access mechanism, urban regeneration market maturity, and regeneration potential will affect the strategies and objectives of enterprises to enter the urban regeneration market.

This study has two main objectives. The first objective is to formulate strategies from a macroscopic perspective, and based on the regional development strategy and regional economic level to present and comprehend a general understanding of the urban renewal development stage and development characteristics. The second objective is to clarify the strategic goals from the cities' perspective, and to provide a reference for enterprises according to the urban regeneration characteristics, market maturity, and urban regeneration potential and development direction of relevant cities, in order to provide strategic decision support for urban regeneration and operation.

Section 2 of this paper presents a literature review that justifies the originality of this research. Section 3 focuses on methods to analyze and quantify the factors that influence urban regeneration development. Section 4 presents a case study to evaluate and judges the characteristics of urban regeneration for four cities in the Pearl River Delta (PRD) of China. Section 5 discusses the output of the system analysis and potential space evaluation and summarizes which city the enterprises should focus on.

2 Literature Review

Coffin and Shepherd identified four key barriers to brownfield redevelopment through a case study analysis of four cities in the United States, including legal liability, limited information, limited financial resources, and limited demand for the properties [4]. Dixon et al. proved that the critical success factors that bring the recessional sites back into use include the presence of strong potential markets, the decision to see the recession as an opportunity, the long-term vision, strong branding, strong partnerships, integrated development, and the right decision to put the infrastructure into place [5]. Frantál et al. explored and identified the factors that affect urban regeneration potential and found that the centrality and transport links factors are positively associated with retail and business development projects, but negatively associated with the projects of housing development and construction of civic amenities [3]. Marti et al. used location-based social networks (LBSN) to identify the places of opportunity for urban regeneration, and a two-fold perspective was adopted, that is, a people-based and a place-based [6]. Chiu et al. applied the Fuzzy Delphi Method (FDM), the Analytic Hierarchy Process (AHP), and the Analytic Network Process (ANP) to develop a model for evaluating the management strategies of urban regeneration stations [7]. This model can serve as a reference for improving policy performance and identifying the relevant key factors to promote urban regeneration by governments. Bottero et al. used the community impact evaluation method to assess the 22@ project (an urban transformation project in Barcelona, Spain) that is integrated with the stakeholder analysis [8]. Their study concluded that the operation impacts were positive with respect to the economic dimension and the environment sphere, and the social integration effects were negligible. Dogan et al. used the multiple-criteria fuzzy decision-making methods to determine the local society's awareness and expectation levels about urban renewal [9]. The authors found that the levels were higher with the local society involvement compared to other residential areas. With Multi-objective Linear Programming (MOLP), Manganelli et al. proposed a model for solving problems that occurred between different stakeholders in a residential generation project located in the city of Matera, Italy [10]. The regeneration participatory phase can also be identified first in selecting objectives and then in selecting the weights in the model to be attributed to the utility functions. Nesticò et al. proposed a selection model based on ANP and zero-one goal programming (ZOGP) to analyze the sustainability of urban regeneration projects [11]. Their results showed that the model could guide the decision-maker towards urban regeneration programs that maximize final benefits. Lai et al. proved that urban sites with high land rent gap levels and low transaction costs are more likely to be redeveloped earlier than their counterparts [2]. Furthermore, land use status and urban planning also significantly influence the spatial variation of land redevelopment.

In all the previously mentioned research studies, many indicators were introduced and several approaches have been used to measure the decision-making process for urban regeneration evaluation. However, there is no consensus to find and access indicators because most cities are highly complex systems [12-14]. Previous studies lack concrete analysis for urban regeneration system and potential, particularly with regard to quantitative research. According to the temporal dimension of the plan, three types of evaluation can be distinguished: Ex-Ante, In itinere, and Ex-Post [8]. The evaluation in this study followed the Ex-Ante evaluation type.

The term "urban regeneration decision making map" is introduced in this study. It follows the national regional development strategy from the perspective of regional division, combined with stages and characteristics of the regional urban regeneration and development. It aims at the strategic layout of CCEED and determines four major research regions (i.e., PRD, Yangtze river delta (YRD), Beijing-Tianjin-Hebei (BTH), and Cheng-Yu (CY), as shown in Figure 1) and the corresponding target cities to carry out special research in China. Each region will consider the target city as the breakthrough point to summarize and judge the characteristics, market participation demand, and condition maturity of urban regeneration from the aspects of policy support, participants, market reaction, and typical cases of urban regeneration. The final conclusions of this study, following the urban regeneration decision-making map, are expected to provide a strategic value for multiple target cities in each research region.

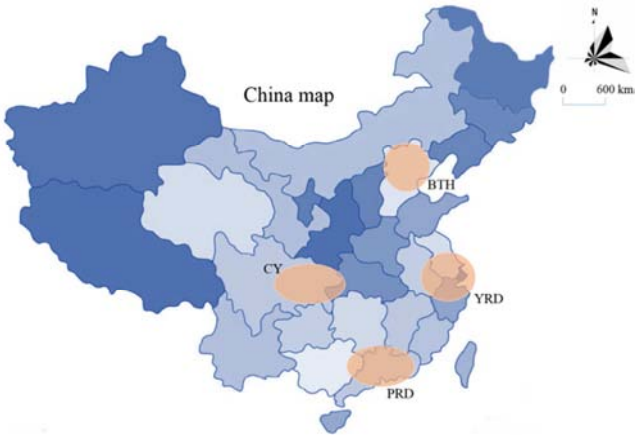

Figure 1. *Regional layout for urban regeneration of CCEED.*

3. Methodology

The framework of decision making map research includes two parts: urban regeneration system analysis and urban regeneration potential space evaluation, as shown in Figure 2. The urban regeneration system will determine the hidden cost in practice, and it will also be an important factor that affects the decision-making process of enterprises. The spatial distribution of renewal potential directly reflects the renewal focus of the target city. A comprehensive urban regeneration system includes urban regeneration policies and regulations, management organization setting, planning, decision making mechanism, development rights and interest acquisition, project implementation requirements, and others. This study will establish a systematic analysis framework to comprehensively show the overall sketch of the renewal system in the target city, and will clearly analyze the complex characteristics of the urban renewal system. Meanwhile, by combining the renewal potential resources of the target city, the study will quantitatively evaluate the renewal potential, in order to provide the most intuitive decision-making basis for enterprises.

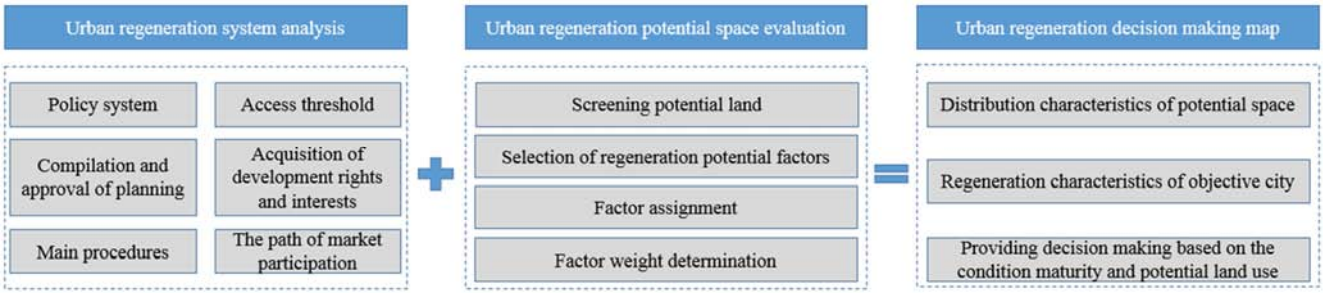

Figure 2. *Framework of decision making map research.*

3.1. Urban Regeneration System Analysis

The urban regeneration system is one of the factors affecting decision making process, because it is essentially the redistribution of power and interests among different stakeholders. Whether the system design is reasonable determines whether the activities such as demolition, transformation or renovation can be carried out smoothly in the regeneration process. In the conclusion of the decision making map, the system perfectness of typical cities is classified as "High", "Relatively high" and "Normal". The more perfect the system, the clearer the development rights and interests that the implementing body can obtain. The urban regeneration system can be classified as follows:

(1) Urban regeneration policy system

This study combines the renewal policy systems of target cities, updates the operation mechanism of institutions, and summarizes the policy characteristics.

(2) Compilation and approval of urban regeneration planning

This study analyzes the urban regeneration planning compilation and examination and approval system that matches the regulations and management documents such as "urban regeneration measures" and "detailed rules for the implementation of urban regeneration measures", and also clarifies the basis of administrative license.

(3) Main procedures of urban regeneration

This study summarizes the general procedures of renewal projects in target cities from project approval to issuance of qualification documents for implementation subjects, and analyzes the approval time limit.

(4) Access threshold of urban regeneration

This study analyzes the core policy document of urban regeneration of the target city, and clarifies the access threshold of urban regeneration, such as the requirements of legal land use, the conditions for market development enterprises to intervene in urban regeneration, and others.

(5) Acquisition of development rights and interests

This study analyzes the spatial control rules of the target city, especially the floor area ratio (FAR) control rules, and clarifies the access to development rights and interests in urban regeneration projects.

(6) The path of market participation in urban regeneration

The management requirements of different types of urban regeneration projects in target cities are also different. This study summarizes the general direction of market development entities to participate in urban regeneration projects in target cities by combining the management provisions of project implementation in various policy documents.

3.2. Urban Regeneration Potential Space Evaluation

The study of urban regeneration system shows the maturity of urban renewal conditions of target cities, which is an important factor in judging the development stage and future development potential of a city. Nevertheless, it is necessary for specific cities to understand the potential space's distribution and types from a more accurate and data-based perspective through the corresponding analysis, in order to help the enterprises clarify the strategic priorities and paths.

According to the relevant urban spatial structure theory, combined with the technologies and data accumulation of urban regeneration projects carried out by the authors of this study, the spatial factors affecting urban regeneration potential are selected for a superposition analysis to obtain the distribution and data characteristics of the target city's regeneration potential, and its spatial characteristics is summarized correspondingly. It is worth noting that due to various difficulties in obtaining the relevant planning data, the selection of factors will be adjusted according to the specific situation in the spatial analysis of regeneration potential.

The urban regeneration potential space evaluation can be classified as follows:

(1) Screening potential land

The research object of urban regeneration potential spatial evaluation is the operational land with renewal potential. The most intuitive performance of lands in the relevant planning is that the current property of land is inconsistent with the planning property. The former was proved, in many previous studies, to be one of the crucial success factors for redeveloping brownfields [5, 15]. Therefore, the regeneration potential land of the target city can be identified and screened by superimposing and comparing the planning status quo of the target city with the planned operational land. The land with a clear urban regeneration potential in the relevant planning, will be directly selected as the object of this study.

(2) Selection of regeneration potential factors

According to previous studies and data accumulation of urban renewal projects carried out by CCEED, this study selects several influencing factors to evaluate the regeneration potential and implements superimposed analysis on the land to evaluate its regeneration potential. These influencing factors are (i) economic feasibility, (ii) functional structure, (iii) urban form, and (iv) architectural age, and more details are provided as follows:

(i) Economic feasibility factors

Economic feasibility factors mainly measure the development cost and economic benefit of potential land. Previous studies proved that financial balance is an important obstacle that urban regeneration projects face [16, 17]. The lower the cost and the higher the benefit, the higher the regeneration potential.

1) *Land use type:* Combined with relevant development experience, commercial land and business land have higher development profit, are easier to balance renewal cost, and have relatively large regeneration potential. Nevertheless, planning is also a political activity [18] and political interference should also be considered in the real analysis [19]. Based on China's 14th Five-year Plan, almost all the old buildings in the downtown of most cities must be renewed due to social benefits, which are occupied in residential lands. Thus, residential lands are considered to have tremendous regeneration potential.
2) *Density Zoning:* Land resources can become the key constraint that affects urban renewal and governance [20], and the intensive use of the land inventory is critical to a successful urban regeneration [21, 22]. Higher rates of regeneration were detected in densely built-up areas [3], and therefore, density zoning has a direct impact on the plot ratio of urban renewal areas, and determines the development rights and interests that market developers can obtain. The higher the development intensity is allowed by the rules, the higher the rent is. The rent gap is an important determinant that stimulates the property-led redevelopment [23-28], so the renewal potential is higher.
3) *Land use scale:* As land sizes increase, the exchange tendencies of property owners increase as well [29]. Plus, the smaller the scale of land use, the easier to coordinate the relationship between various stakeholders [15]. The process of urban regeneration is relatively simple, and the potential of urban renewal is strong.

(ii) Functional structure factors

Functional structure factors mainly measure the importance of potential land in the urban development structure; the better the traffic location and the closer to the urban center, the higher the regeneration potential.

1) *Traffic location:* Compared with the general mode of transportation, metro stations can drive the high-intensity development of land [30-33], and form a peak within a reasonable walking range [34-37], which is also in line with the Transit Oriented Development (TOD) development principle.
2) *Central location:* The centrality reflects the accessibility and regional competitiveness since it is positively associated with retail and business development projects [3]. The population distribution is significantly impacted by distance to the nearest center [38]; and thus, the closer to the service center, the greater the development potential. The central location has been regarded as a key determinant for urban regeneration [39, 40].

(iii) Urban form factors

Urban form factors mainly measure the relationship between potential land use and urban ecology. The closer the land to mountains, rivers, parks, and important urban roads, the higher the regeneration potential.

1) *Natural landscape location:* Good landscape indicates sound environmental ecology. River, public green space,

and other landscape resources have a special distance attenuation effect on the distribution of FAR. The development intensity of a land directly facing a public green space or a river is often very high; and thus, the regeneration potential is also significant.

2) *Key streets:* Distance to the main road is significantly and negatively associated with the redevelopment outcomes [2]. The passenger and bus lines along main urban axes are relatively concentrated [6], and the accessibility of motor traffic in the area with high density of urban road network is also good, which can actively drive the land development along the line and has high renewal potential.

(iv) Architectural age factors

The building age factor mainly measures the quality and built environment of the buildings in the potential land. The building quality and built environment of the residential areas built in recent years are generally better than those built earlier. Minimum standards of comfort need to be improved by repair and maintenance processes to achieve minimum building quality standards [41, 42]. Furthermore, building inheritors have positive relationships with the age of the residential area [43], where old buildings are aggregated. Thus, the demand for renewal for the residential areas with old buildings is more urgent.

(3) Factor assignment

The rules of factor quantification and assignments are as follows:

(i) Land use type

According to the regeneration potential, land types are assigned including residential land 3, commercial and business land 2, and storage and industrial land 1.

(ii) Density zoning

FAR is the ratio of a building's total floor area to the size of the piece of land upon which it is built [44], and it is used in the zoning process to limit urban density. A high planned FAR suggests a high possibility to gain profit from a redevelopment project [2]. According to the density zoning planning of the target city, FAR is divided into three levels: a high-density area assigned to 3, a medium-density area assigned to 2, and a low-density area assigned to 1.

(iii) Land use scale

According to the potential land use scale, the land use scale of less than 1 hectare is assigned as 3, the land use scale between 1 and 5 hectares is assigned as 2, and the land use scale of more than 5 hectares is assigned as 1.

(iv) Traffic location

Traffic location elements include two types of key transport hubs and general metro stations, and the key transport hub has a larger radiation range than the general metro station. According to the accessibility of public transport impact, the parameters are assigned as follows: (a) assignment 3 for the land within 300 meters of the general station or 800 meters of the key transport hub, (b) assignment 2 for the land within 500 meters of the general station or 1500 meters of the key transport hub, and (c) assignment 1 for the remaining lands, as shown in Figure 3.

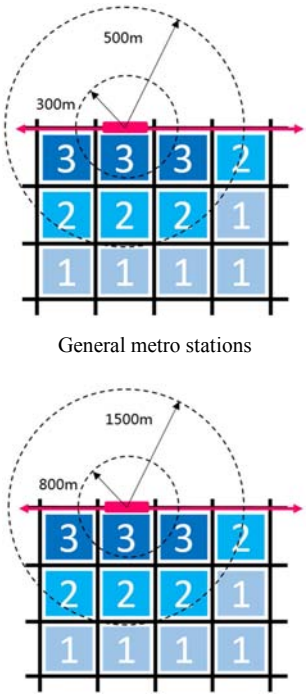

Figure 3. *Traffic location assignments.*

(v) Central location

According to the relevant planning, the urban comprehensive center (the main center and the sub-center) and the cluster center are divided into two types. The land within 500m of the urban comprehensive center is assigned as 3, the land between 500 and 800m of the urban comprehensive center or within 500m of the cluster center is assigned as 2, and the land for other areas is assigned as 1, as shown in Figure 4.

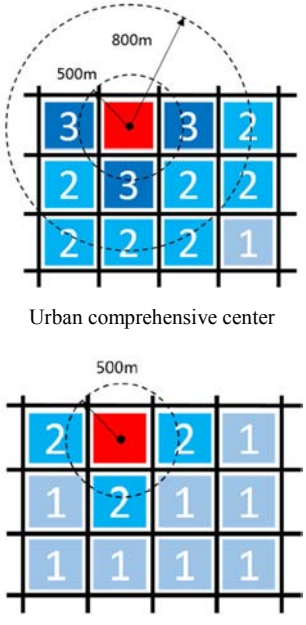

Figure 4. *Central location assignments.*

(vi) Natural landscape location

The coast, mountains, large parks, and important rivers of the target city are selected as the main landscape factors, and other rivers and important public green space are selected as the secondary landscape factors. Among those factors, the scale of public green space (excluding the narrow and long green belt) is within a range of 2-10 hectares, and that of large parks is more than 10 hectares. According to previous studies, parks or rivers have the most significant impact on the intensity of land development within 100m of the surrounding area, and the parameter assignments based on the landscape environment location are as follows: the land within 200m of the main landscape factor is assigned as 3, the land within 100m of the secondary landscape factor is assigned as 2, and the other areas are assigned as 1, as shown in Figure 5.

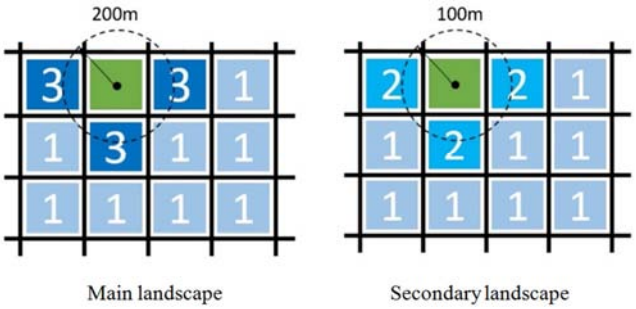

Figure 5. *Natural landscape location assignment.*

(vii) Key streets

The main non-traffic roads of the target city are selected as the key streets of the city. The land within 200m of the key streets is assigned as 2, and the other areas are assigned as 1, as shown in Figure 6.

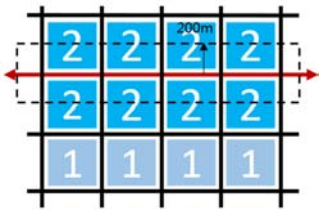

Figure 6. *Key streets assignments.*

(viii) Architectural age factor

The building age of the residential buildings in the area was considered the basis of assignment, and residential buildings constructed before 2000 were considered the main factor in judging the renewal potential. The Kernel density distribution is then obtained through the analysis of the Geographic Information System (GIS). The highest density circle is assigned as 3, the middle density circle is assigned as 2, and the other areas are assigned as 1.

Based on the above analysis, factor quantification is put forward as shown in Table 1.

(4) Factor weight determination

The factor judgment matrix is established, and the weight of each factor is determined by the AHP, as presented in Table 2 and Table 3.

4. Case Study

4.1. General Situation

The PRD region is located in the south of China, as shown in Figure 7. Its urban renewal began with the "Three Old Renewal" [45] and takes the highly market-oriented urban renewal implementation as the core feature instead of the "top-down" approach [46]. Typical cities include Shenzhen, Guangzhou, Zhuhai, and Dongguan.

Table 1. *Rule of factor quantification.*

Factor type	Influential factor	Zoning criterion	Assignment
Economic feasibility factors	Land use type	Residential land	3
		Commercial and business land	2
		Others	1
	Density zoning	Grade I	3
		Grade II and III	2
		Grade IV and V	1
	Land use scale	Smaller than 1 hectare	3
		Between 1 hectare and 5 hectares	2
		Larger than 5 hectares	1
Functional structure factors	Traffic location	Within 300 meters of the general metro station or 800 meters of the key transport hub	3
		Within 500 meters of the general metro station or 1500 meters of the key transport hub	2
		Others	1
	Central location	Within 500m of the urban comprehensive center	3
		Between 500 and 800m of the urban comprehensive center or 500m of the cluster center	2
		Others	1
Urban form factors	Natural landscape location	Within 200m of the main landscape factor	3
		Within 100m of the secondary landscape factor	2
		Others	1
	Key streets	Within 200m	2
		Others	1
Architectural age factors	/	High density circle before the year of 2000	3
		Middle density circle before the year of 2000	2
		Others	1

Table 2. *Factor judgment matrix.*

2-1. Factor type comparison

Factor type	Economic feasibility factors	Functional structure factors	Urban form factors	Architectural age factors
Economic feasibility factors	1	3	5	4
Functional structure factors	1/3	1	3	3
Urban form factors	1/5	1/3	1	1/2
Architectural age factors	1/4	1/3	2	1

2-2. Economic feasibility factor comparison.

	Land use type	Density zoning	Land use scale
Land use type	1	1/5	1
Density zoning	5	1	7
Land use scale	1	1/7	1

2-3. Functional structure factor comparison.

	Traffic location	Central location
Traffic location	1	1
Central location	1	1

2-4. Urban form factor comparison.

	Natural landscape location	Key streets
Natural landscape location	1	1/5
Key streets	5	1

Table 3. *Weight of factors.*

Factor type	Influential factor	Partial weight	Type weight
Economic feasibility factors	Land use type	0.15	0.53
	Density zoning	0.7	
	Land use scale	0.15	
Functional structure factors	Traffic location	0.5	0.26
	Central location	0.5	
Urban form factors	Natural landscape location	0.17	0.08
	Key streets	0.83	
Architectural age factors	/		0.13

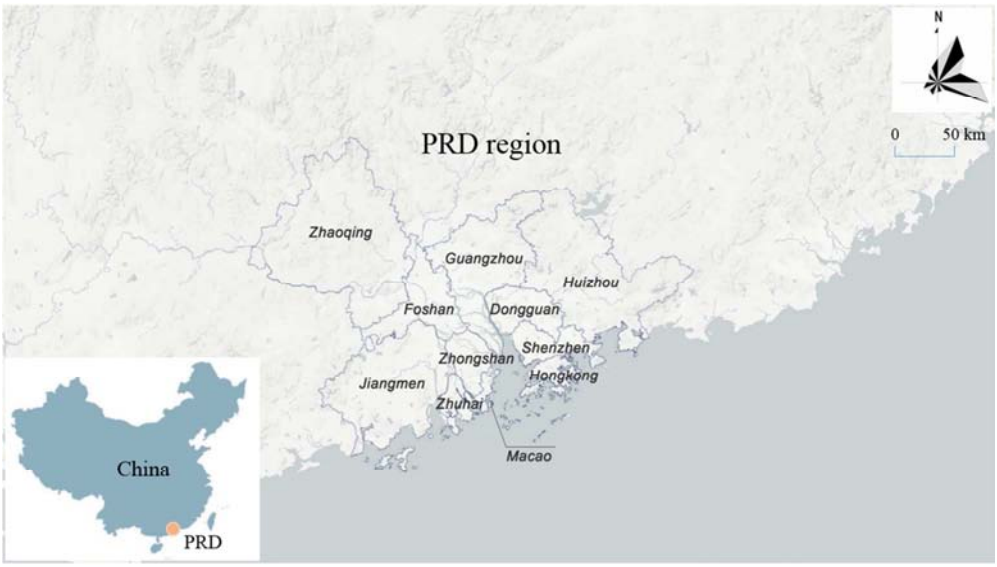

Figure 7. *Location of PRD region in China.*

As a unique urban renewal method in the PRD region, the "Three Old Renewals" represents the "renewal of old neighborhoods, factories, and villages in the city", and it is characterized by breaking through the original land and

resources policy. Remarkable achievements have been made in simplifying the procedures for expropriation, adopting agreements to transfer, allowing scattered land into the scope of transformation, and properly handling problems left over from the past. The updated method is constantly being refined and optimized.

Meanwhile, high marketization is a major feature for the implementation of urban regeneration in the PRD region, especially in Shenzhen city, which gives a great advantage to the region to play a higher role in urban regeneration compared with other cities in China [47, 48]. Apparently, as the first region to explore urban regeneration, it enjoys the policy advantages that other regions do not have. Therefore, urban regeneration in this region also presents distinctive characteristics compared with other regions [46]. Sections 4.2 and 4.3 will focus on Shenzhen city as a case study to analyze and evaluate the urban regeneration decision making map, i.e., the urban regeneration system and the potential space.

4.2. Urban Regeneration System

(1) The multi-level policy system with regulations as its core

After practicing urban renewal and system innovation since 2009, Shenzhen has formed a multi-level system with the Regulations of Shenzhen Special Economic Zone on Urban Regeneration (RSSEZUR), Measures for Urban Regeneration of Shenzhen City (MURSC), and Detailed Rules for the Implementation of the Measures for Urban Regeneration of Shenzhen City (DRIMURSC) as guiding regulations. These guiding regulations cover a series of policy documents including different aspects of regulatory provisions, technical standards, and operational guidelines, as shown in Figure 8. The urban regeneration system of Shenzhen has always adhered to the RSSEZUR, MURSC, and DRIMURSC, regulating the development of local urban renewal work through more detailed complementary policies such as the Interim Measures for Strengthening and Improving the Implementation of Urban Regeneration (IMSIIUR). Furthermore, with periodic revision and optimization of the IMSIIUR, Shenzhen can deal with many problems in the practice of urban regeneration with a higher flexibility.

(2) Urban regeneration planning system of Shenzhen

(i) Technical system of multi-level urban regeneration planning

The urban regeneration plan of Shenzhen has established a multi-level and commendable technical system framework from the master planning to the parcel planning, and has formed a good link and complement with the existing statutory planning system, as shown in Figure 9. Special Urban Regeneration Planning, such as the 13th Five-Year Plan of Urban Regeneration in Shenzhen which was prepared at the macro level and served as the overall guidance, mainly stipulates the principles, objectives, spatial management, and control of urban renewal. It also serves as a guiding document for the recent implementation planning, such as the priority of urban renewal demolition and reconstruction area, demolition and comprehensive rehabilitation area, limit demolition and reconstruction area, basic ecological control line, approved urban regeneration parcel planning (URPP) scope, and others. Based on the statutory planning, the main contents of URPP are renewal objectives, methods, control targets, infrastructure, public service facilities and urban design guidelines, and others. It is necessary to define the range of demolition land, public interest land, and development land in the renewal parcel.

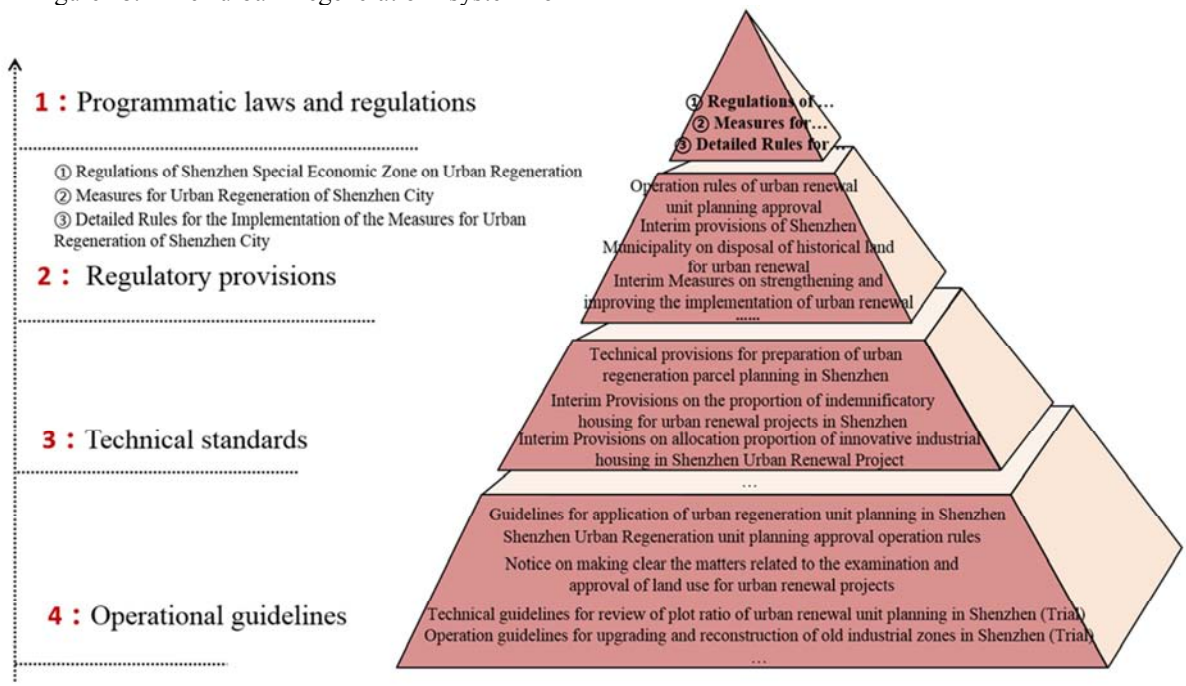

Figure 8. *Urban regeneration system of Shenzhen City.*

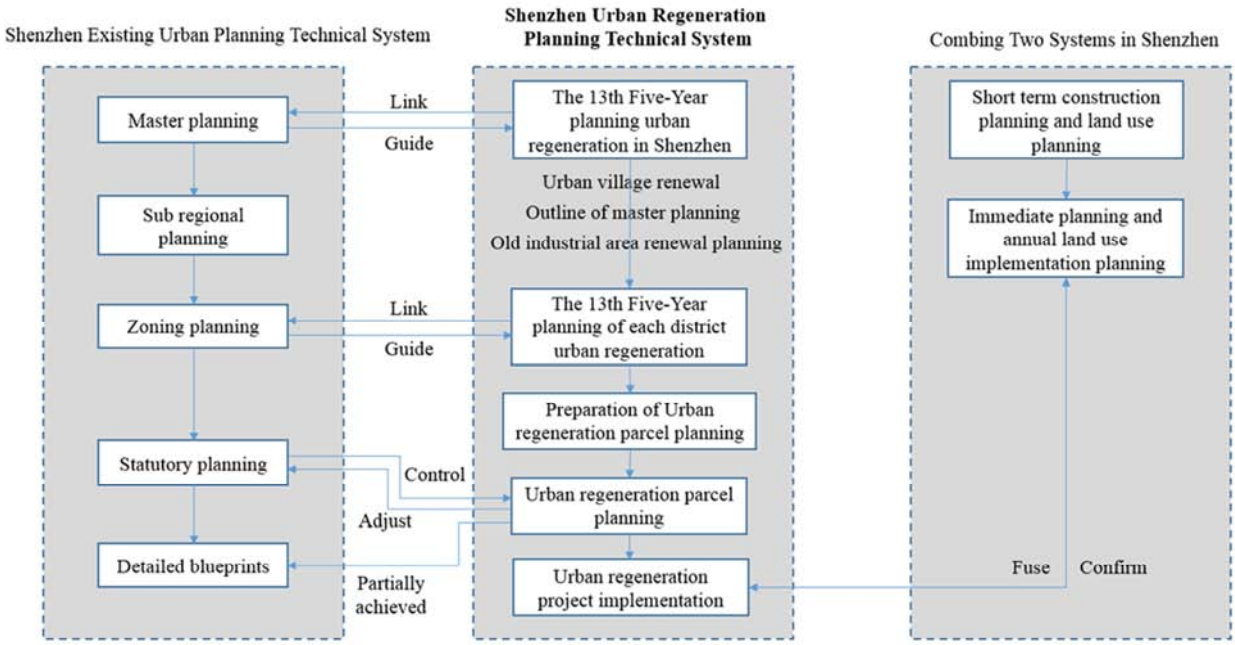

Figure 9. *Frameworks of Urban Regeneration Technology System in Shenzhen City.*

(ii) Urban regeneration parcel planning (URPP)

At the technical level, in order to standardize the preparation of the URPP and connect the approval and implementation of urban regeneration, Shenzhen issued the "Technical Provisions for Preparation of URPP in Shenzhen (Trial)" in 2011, which considers the URPP as the primary platform for the management of demolition and reconstruction. Furthermore, Shenzhen officially issued the Demolition and Reconstruction Plan Technical Regulations on the Compilation of URPP in Shenzhen, which clearly stipulates that the URPP is regarded as an important part of statutory plans. This regulation can be considered to be a partial adjustment of statutory plans after approval. Furthermore, this regulation connects horizontally with the approval operation of the URPP, refines the elements of upper-level planning, connects vertically with the statutory planning and URPP, and introduces requirements for the next stage of administrative approval.

(iii) Urban regeneration overall planning at district level (UROPDL)

From 2009 to 2012, several districts in Shenzhen carried out urban regeneration planning research, mainly entrusted by the government, taking the streets in the area under its jurisdiction as the planning object, and the relevant planning research results were subsequently transformed into the five-year special plan of urban regeneration at the district level. This kind of urban regeneration planning research work is gradually derived from the actual needs of interest adjustment in the process of urban regeneration exploration and practice. From 2014 to 2015, and due to the gradual exposure of URPP's cumulative problems, the government began to explore the coordinated implementation path; however, the legal basis and status of urban regeneration planning in this period were not clear. Since 2016, Shenzhen has implemented urban renewal and decentralization. All districts have taken the initiative to strengthen the UROPDL, and gradually defined its role and status in relevant policies, in order to strengthen the government's leading force, balance the overall interests of each district, and implement major public infrastructure.

(3) Acquisition of development rights and interests

(i) The composition of planning volume

The parcel planning volume directly reflects the benefits that developers can obtain from urban renewal activities. Therefore, the development intensity control is the core system of Shenzhen to regulate the distribution of urban renewal benefits. According to the relevant regulations of Shenzhen, the planning volume of the parcel is composed of three parts: a basic volume, a transfer volume, and an incentive volume.

According to the micro-location influence conditions (parcel scale, surrounding roads and subway stations, etc.), the basic volume of the parcel is the volume part that is modified based on the benchmark parcel ratio determined by the density zoning. The transfer volume is the volume part modified by the specific conditions of the parcel development, such as public service facilities, municipal transportation facilities, historical and cultural protection, green space public space system, etc. The incentive volume is the volume part to guarantee the realization of the public interest, and the maximum incentive volume of the plot does not exceed 30% of the basic volume.

(ii) Land density zoning

The FAR grades of land with different land use types are divided into 3 to 5 grade intervals, and the corresponding basic FAR and maximum FAR need to meet the related regulations. For example, the guidelines for FAR of residential land is shown in Table 4. The density zoning of construction land in Shenzhen is shown in Figure 10.

Table 4. *Guidelines for FAR of residential land in Shenzhen.*

Grade	Density Zoning	Basic FAR	Max FAR
1	Grade I and II	3.2	4.5
2	Grade III	3.0	4.0
3	Grade IV	2.5	3.3
4	Grade V	1.5	2.5

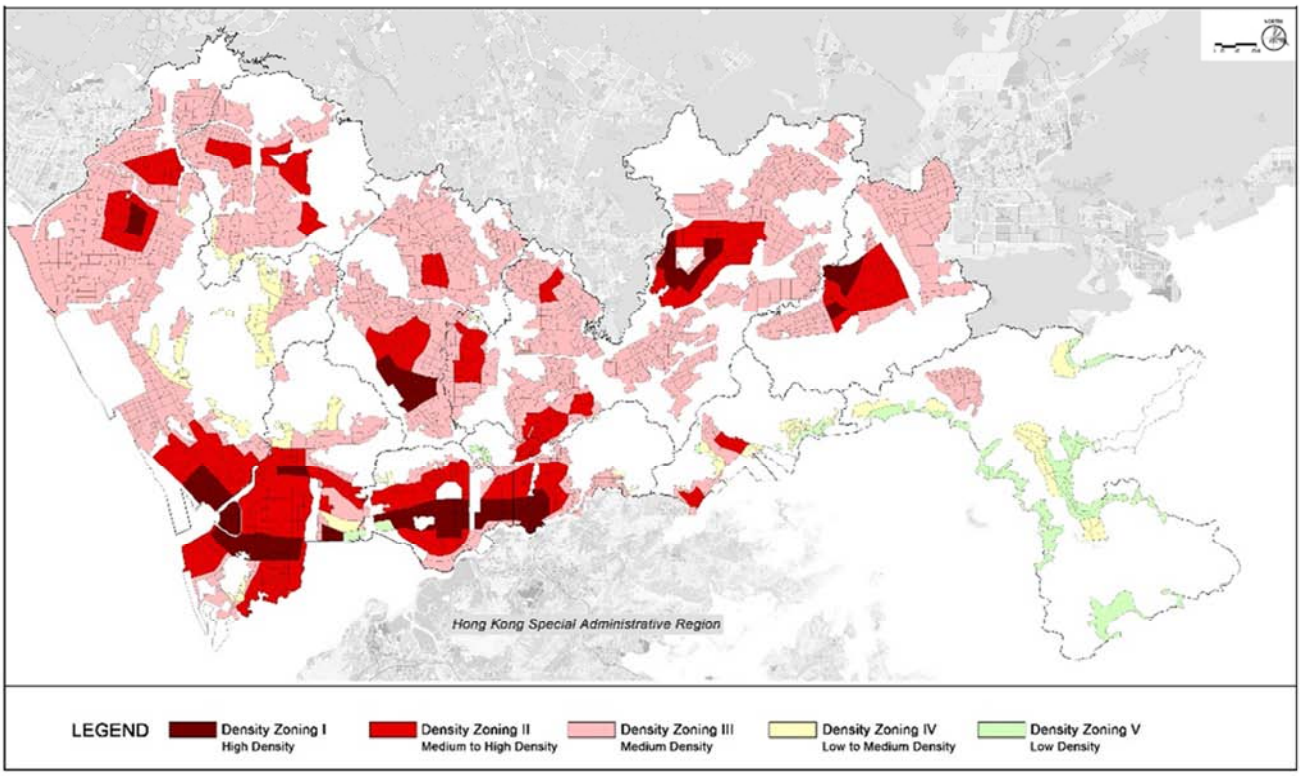

Figure 10. *Guide map of construction land density zoning in Shenzhen.*

4.3. Urban Regeneration Potential Space Evaluation

(i) Composition and scale of renewal potential land

Based on the relevant planning of Shenzhen, the potential land for urban regeneration in Shenzhen is 104.73 km^2, and the distribution of various types of land is shown in Table 5. At present, residential land and industrial land account for a large proportion of renewal potential land in Shenzhen, as shown in Figure 11. In the future, the supply of residential land and industrial land will be in a dominant position. From the perspective of potential land distribution, Baoan, Longhua, and Longgang are the districts with the most regeneration land in the future.

(ii) Factor selection and assignment

According to the technical route of urban regeneration potential space evaluation, combined with the relevant planning of Shenzhen, this study analyzes the relevant data from the aspects of economic feasibility, functional structure, urban form, and architectural age.

Based on the data of Shell network, there are 4282 valid residential areas with available building age information; among them, 1610 old residential areas were built in or before 2000, accounting for 37.6%. The distribution of residence samples in Shenzhen in different years is shown in Figure 12. Building age is divided into five stages: before 2000, 2001-2005, 2006-2010, 2011-2015, and 2016 to the present. The Kernel density analysis is carried out respectively, and the distribution density of residential areas of different ages is obtained. It is found that the density of old residential areas is the highest in the old street area of Luohu district. The analytical output of all the evaluation factors is introduced as shown in Figure 13.

Table 5. *Statistical table of composition and scale of potential land for renewal in Shenzhen.*

Land type	Area of regeneration potential land (km^2)	Scale
Residential land	47.23	45.1%
Commercial and business land	12.29	11.7%
Industrial and manufacturing land	43.54	41.6%
Logistics and warehouse land	1.67	1.6%
Sum	104.73	100%

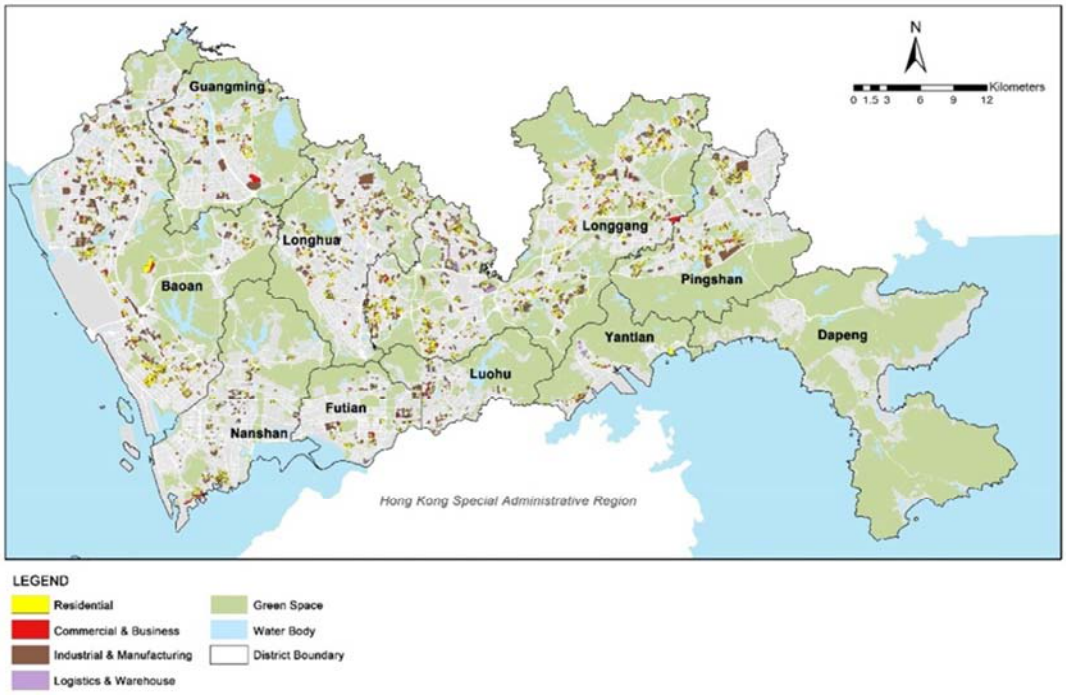

Figure 11. *Distribution of regeneration potential land in Shenzhen.*

(iii) Output of regeneration potential evaluation

Based on the methodology presented in Section 3, the previously mentioned evaluation factors are superimposed to get the result of Shenzhen's urban regeneration potential evaluation, as shown in Figure 14. The area and proportion of high, medium, and low potential land are shown in Table 6 and Figure 15. Figure 16 shows the composition of high potential land in different land use types.

From the perspective of the entire city, the proportion of high potential regeneration land is low, and the spatial potential distribution of each district is significantly different. The high potential regeneration land only accounts for 4.6% of the total. The distribution area and scale of high, medium, and low potential land in each district are shown in Table 7.

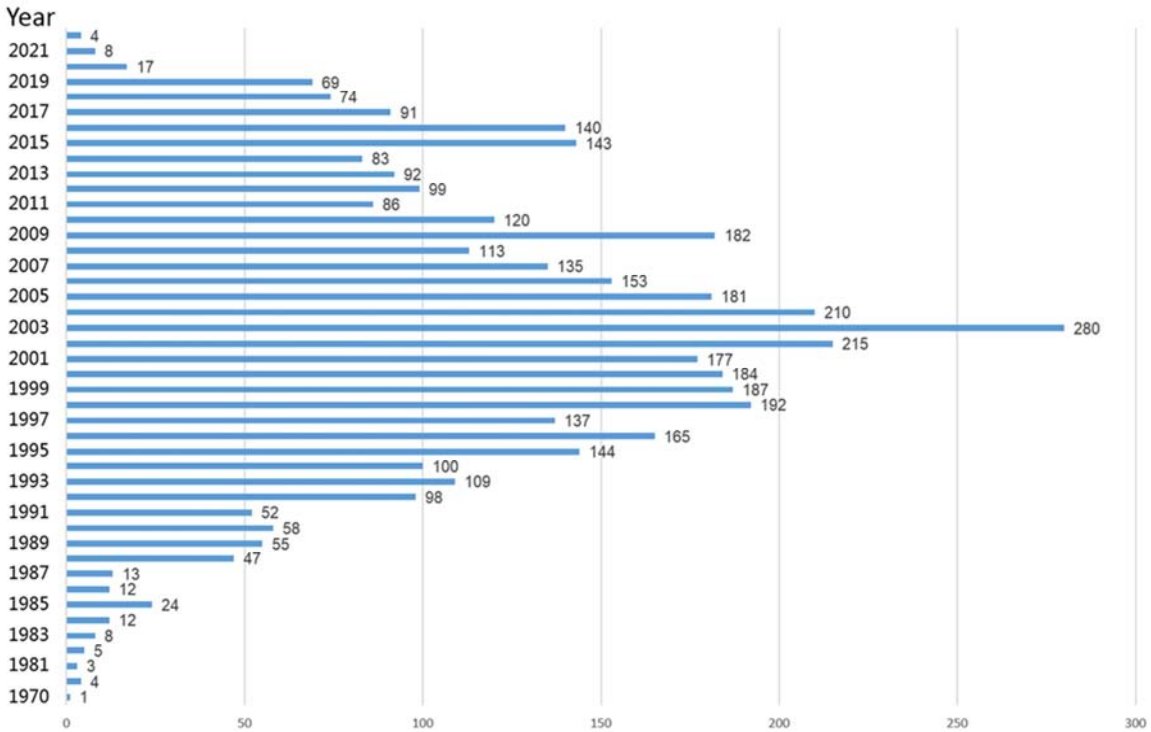

Figure 12. *Yearly distribution of residence samples in Shenzhen.*

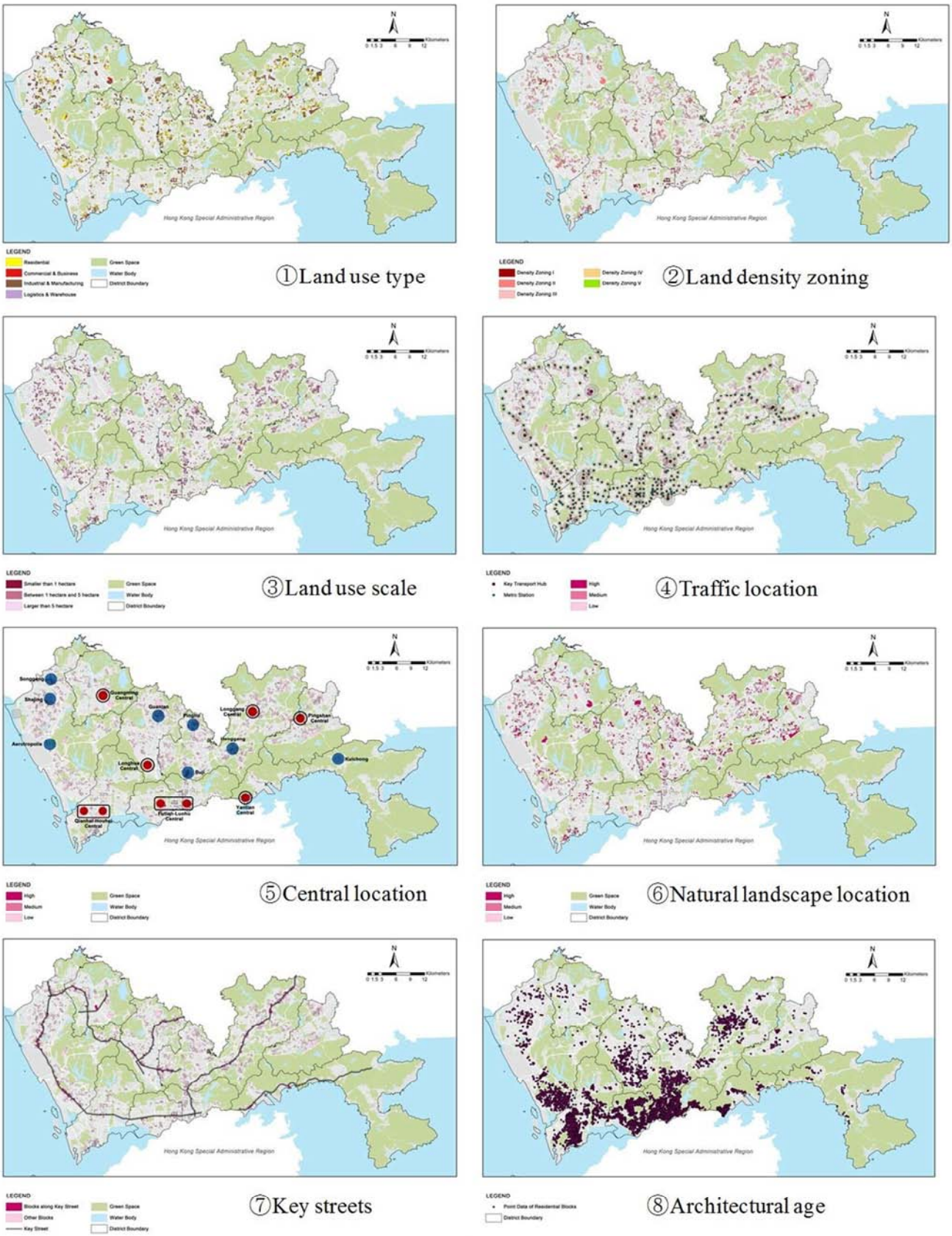

Figure 13. *Evaluation Factors of Regeneration Potential Land use in Shenzhen.*

5. Discussion

5.1. Regeneration System

The same analysis was performed for the other three cities in the PRD region. Through the horizontal comparison of the four target cities' regeneration system, and the comprehensive evaluation based on the sustainability of local policies (Table 8), this study finds that the urban regeneration system of Shenzhen city is the best, followed by Guangzhou, Zhuhai, and Dongguan cities.

Due to the small land area, the land resources of Shenzhen are increasingly scarce with the rapid development of many years; therefore, the urban regeneration started earlier. After years of improvement, a relatively sound system has been established. Particularly in the three aspects of protecting public interests, reserving industrial development space, and urban sustainable development, Shenzhen has formulated a series of supporting urban renewal laws and regulations, with the most standardized urban renewal management and the most mature urban renewal market. In Shenzhen, where urban regeneration follows the mode of market-led government supervision, the government helps the developers to promote urban regeneration processes, mainly focusing on the decision-making process [49].

The city of Guangzhou implements zoning control on the development intensity of urban regeneration. Considering that the development intensity is closely related to the value-added benefits of urban regeneration, it is divided into four types of intensity zoning, which can be used as an important reference for implementing renewal areas and project parcels. In the actual operation process, the development intensity of individual villages in the city needs to calculate the comprehensive transformation cost through the basic data survey, and then calculate the total building area from the comprehensive transformation cost. Guangzhou's urban regeneration also started early, and has experienced the transformation and development from "Three Old Renewal" to the comprehensive urban renewal. The regeneration system is constantly iterative, new, and perfect. The government dominates Guangzhou's urban regeneration system. For example, in the comprehensive transformation of old villages, the compensation standard for demolition is set by the government, and the government will assist in promoting the transformation of old villages.

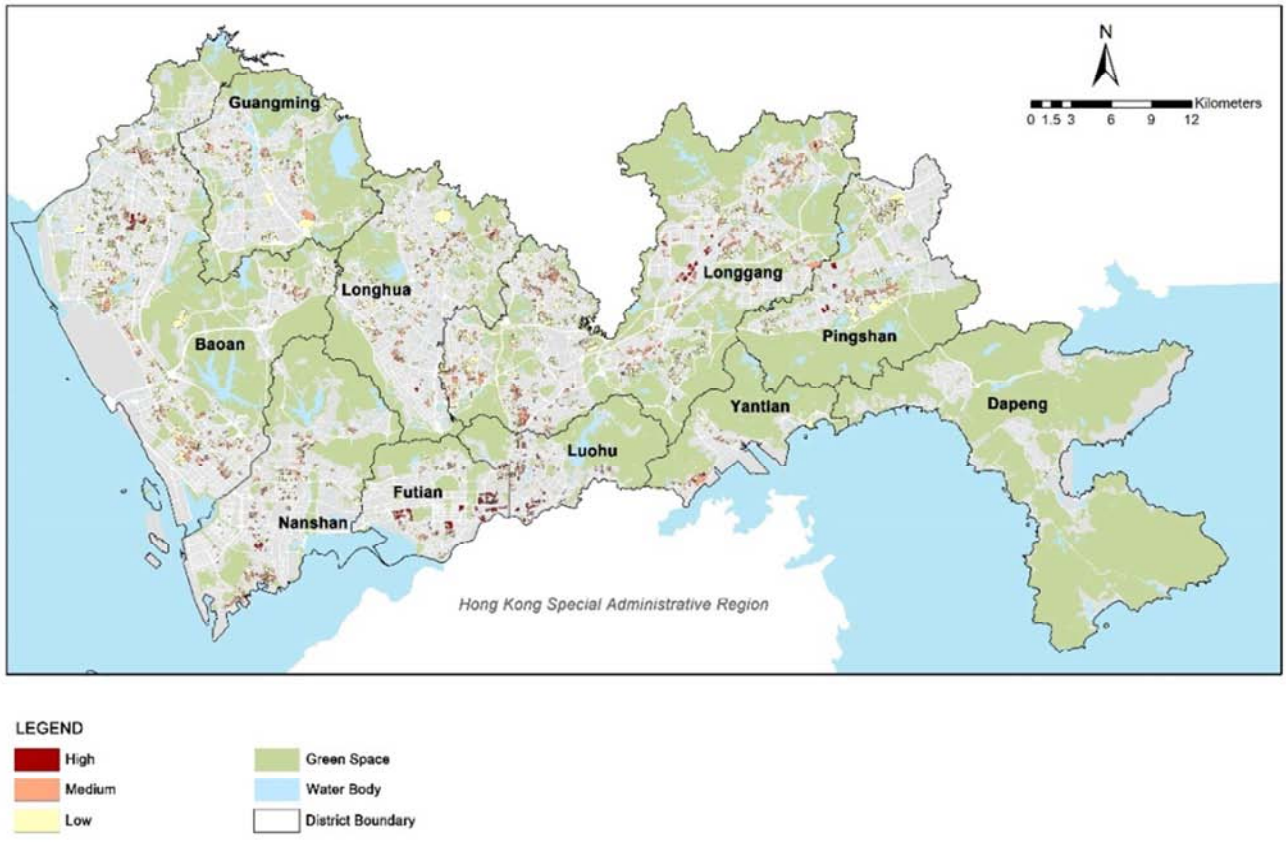

Figure 14. *Evaluation outcome of regeneration potential land in Shenzhen.*

Table 6. *Statistical table of potential land use evaluation.*

Proportion	Area(km^2)	Scale
High potential land	4.79	4.6%
Medium potential land	29.18	27.9%
Low potential land	70.76	67.6%

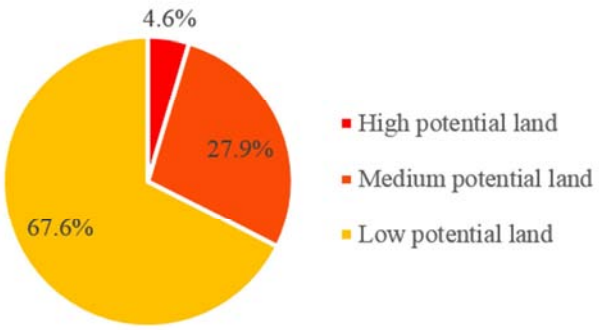

Figure 15. *Proportion of land with different potential.*

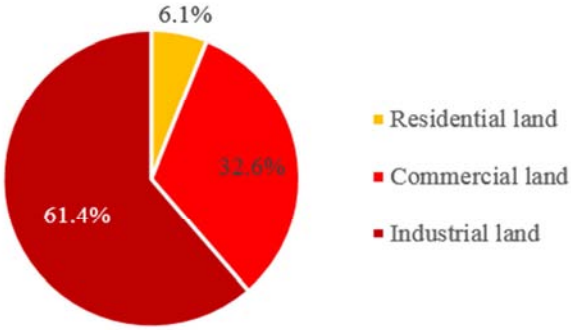

Figure 16. *Composition of high potential land use types.*

Table 7. *Statistical table of potential land use evaluation in each administrative district.*

Administrative District	High Potential (km^2)	Medium Potential(km^2)	Low Potential (km^2)	Total (km^2)	Scale
Futian	1.65	1.22	1.03	3.90	3.7%
Luohu	0.49	1.31	0.55	2.35	2.2%
Nanshan	0.33	2.90	2.41	5.64	5.4%
Yantian	0.16	0.73	0.90	1.79	1.7%
Longhua	0.29	2.42	9.22	11.93	11.4%
Baoan	0.64	6.23	19.68	26.55	25.4%
Guangming	0.05	2.05	6.31	8.41	8.0%
Longgang	0.83	10.85	22.27	33.95	32.4%
Pingshan	0.36	1.46	8.16	9.98	9.5%
Dapeng	0.00	0.00	0.22	0.22	0.2%

Table 8. *Comparison of the regeneration system for four target cities.*

		Shenzhen	Guangzhou	Zhuhai	Dongguan
Organization		Bureau of Planning and Natural Resources	Bureau of Planning and Natural Resources, Housing and Urban Rural Development Bureau	Bureau of Natural Resources	Bureau of Natural Resources
Core document		Urban regeneration regulation, Urban regeneration measures, Measures for the implementation of urban regeneration	Urban regeneration measures	Urban regeneration management measures	Measures for the implementation of urban regeneration
Acquisition of development rights and interests	Density zoning	Have	Have (only for urban regeneration)	Have	Have
	FAR calculation rule	Have	Not have	Have	Have
	Volume prediction based on economic feasibility	Not have	Have	Have	Not have
	Dominance of development rights and interests	Game among market, government and aborigine	Government	Government	Government
System perfectness		High	Relatively high	Normal	Normal

The development intensity control of urban regeneration in Zhuhai and Dongguan draws lessons from Shenzhen's density zoning and FAR calculation rules, and stipulates that the planning building area of urban renewal parcels should consist of a basic building area, an incentive building area, and a compensation building area. Due to the small administrative area, the contradiction between land supply and demand of Dongguan and Zhuhai is prominent after years of development. The two cities also draw lessons from the practical experience of Shenzhen in urban regeneration policy-making, and make innovations in combination with their own characteristics. The system is relatively complete, but the guidelines are slightly weak, and the degree of perfection is general.

5.2. Regeneration Potential

A similar evaluation was carried out for the other three cities in the PRD region. Compared with the potential land use of the four target cities, Dongguan has the largest total land use, reaching 548 km^2 and including 409 km^2 of residential land, accounting for 74.6%. The scale of renewal land in Zhuhai is the smallest, with only 38 km^2. From the perspective of regeneration potential, Dongguan has the highest proportion of high potential regeneration land, accounting for 29.4%. In contrast, Shenzhen has the lowest proportion of high potential regeneration land, accounting for only 4.6%, as shown in Table 9.

Table 9. *Spatial comparison table of regeneration potential of four target cities.*

	Shenzhen	Guangzhou	Zhuhai	Dongguan
Regeneration land area (km^2)	104.73	128.12	38.02	548.50
Residential land (km^2)[*]	47.23	87.05	26.73	409.29
Scale[*]	45.1%	67.9%	70.3%	74.6%
High potential regeneration land area (km^2)	4.79	26.13	5.59	161.34
Scale	4.6%	20.4%	14.7%	29.4%
Residential land (km^2)[#]	2.94	20.46	3.49	120.79
Scale[#]	61.4%	78.3%	62.4%	74.9%

[*] within the regeneration land area
[#] within the high potential regeneration land area

6. Conclusion

In summary, among the four target cities, it is more difficult to carry out urban regeneration projects in Shenzhen and Guangzhou, while it is less difficult in Zhuhai and Dongguan. The laws and regulations of Shenzhen and Guangzhou are excellent and there are many kinds of control conditions. The implementers can strive for less flexible space, and there are risks such as the possibility of a slow progress of the project and the difficulties in achieving the expected development profit, because all renewal projects in Guangzhou are led by the government. In addition, urban regeneration has been carried out earlier in Shenzhen and Guangzhou, and many projects with a high proportion of legal land, low demolition cost, and low implementation difficulty have been completed. In the future, it will be even more challenging to implement urban renewal projects in the two cities. Although the economic level is the main driving force for regeneration [50], which is higher in Shenzhen than that in other cities, the control conditions of the system and stock land are more strict.

On the other hand, the system of Zhuhai and Dongguan is generally good, and some policies need to be further adjusted in practice. Therefore, there is a relatively more flexible space for the implementers. As far as the urban development stage is concerned, and due to the developed manufacturing industry, the current land development intensity in Dongguan far exceeds that in Zhuhai, and the demand for urban renewal is more urgent.

Therefore, this study suggests that Dongguan's urban regeneration market should be the focus of enterprises.

Furthermore, what the enterprises should focus on is not only the regeneration system and potential distribution, but also the public engagement. As Zhang et al. argued, government-led redevelopment helps to enhance the community resilience of urban villages through economic empowerment for residents and formalization of informal economic activities; yet is negatively affected by insufficient public engagement [51]. In an era where urban sprawl and urban shrinkage coexist, as the decision makers of the enterprises (i.e., CCEED), urban regeneration and re-use play important roles, not only in the reuse of physical space, but also in the governance of functional space and human behavior of emotional space regeneration.

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