Forecast and Pattern Analysis of Land Supply and Demand in Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract

The construction of the Guangdong-Hong Kong-Macao Greater Bay Area is an important aspect that cannot be ignored in comprehensively promoting the mutually beneficial cooperation between the Mainland, Hong Kong and Macau, and supporting the merger of Hong Kong and Macau in the overall national development. The economic cooperation and development in the Guangdong-Hong Kong-Macao Greater Bay Area are inseparable from land resources. The contradiction between the limited land resource carrying capacity and long-term development needs is the core issue of urban agglomeration development. Based on the land use conditions in the Guangdong-Hong Kong-Macao Greater Bay Area, the grey forecast model mean GM (1,1) was used to forecast the land demand in this bay area, and ArcGIS was used to predict its potential supply of construction land. According to the analysis of the results, it is found that by 2025, the construction land in the Guangdong-Hong Kong-Macao Greater Bay Area can basically meet the needs of the expansion of built-up areas, but the contradiction between land supply and demand is outstanding in some cities. In the future, the development of regional land space should be expanded from the coast of the Pearl River Estuary to the surrounding areas. And based on inter-city transportation infrastructure, promote regional cooperation to expand land use space At the same time, tap the potential of existing construction land to strengthen intensive land use.

Keywords

Land supply and demand; Land use pattern; Guangdong-Hong Kong-Macao Greater Bay Area; Urban agglomeration.

1. INTRODUCTION

Land is an important carrier of urban economic development. The state of land supply and demand has an important impact on the healthy development of the city. At present, the main contradiction in China's land use is the contradiction between supply and demand of land resources. The development of industrialization and urbanization has stimulated the demand for construction land, and the primary industry is the basic industry needed to guarantee the daily production and life of the people. Limited land resources cannot meet the needs of various industrial sectors at the same time is the current major land problem [1]. The core cities of urban agglomerations have developed economies, and multiple cities play a pivotal role in the national economy, which determines that the natural resource consumption rate of urban agglomerations is much higher than that of a single city. Therefore, rational use of resources is a basic requirement to ensure sustainable development of urban agglomerations.

The Guangdong-Hong Kong-Macao region is one of the regions with the closest economic relations in China. The March 2017 government work report put forward the need to "study and

formulate the development plan for the Guangdong-Hong Kong-Macao Greater Bay Area", which indicates that the construction of the Guangdong-Hong Kong-Macao Greater Bay Area has officially become a national level development strategy. In October 2017, the report of the 19th National Congress of the Communist Party of China proposed to promote the construction of the Guangdong-Hong Kong-Macao Greater Bay Area on the basis of promoting mutually beneficial cooperation between the Mainland, Hong Kong and Macau. In February 2019, the Central Committee of the Communist Party of China and the State Council issued the "Outline of the Development Planning of the Guangdong-Hong Kong-Macao Greater Bay Area", which is a programmatic document guiding the current and future cooperation development of this bay area. The plan clearly proposed that the Guangdong-Hong Kong-Macao Greater Bay Area should implement the new development concept of "green development and ecological protection".

In this study, the grey prediction model mean GM (1,1) was used to predict the land demand in the Guangdong-Hong Kong-Macao Greater Bay Area, and ArcGIS was used to predict its potential supply of construction land. This study aims to provide scientific basis for alleviating the land supply and demand contradictions in the Guangdong-Hong Kong-Macao Greater Bay Area and forming a healthy pattern of coordinated development of land supply and demand in this bay area.

2. DEVELOPMENT STATUS AND GOALS OF GUANGDONG-HONG KONG-MACAO GREATER BAY AREA

2.1. Development Status

The Guangdong-Hong Kong-Macao Greater Bay Area consists of the Pearl River Delta, Hong Kong and Macau, which is located on the southeast coast of China. Due to its natural geographical conditions, it has formed a unique estuary delta landscape. In recent years, the connection of transportation facilities between cities in this urban agglomeration has provided conditions for land-use cooperation across urban administrative boundaries.

The construction of the Guangdong-Hong Kong-Macao Greater Bay Area is the common demand of the regional economic transformation of the Pearl River Delta and the development of urban development space in Hong Kong and Macau.

For the Pearl River Delta, since the 2008 economic crisis, export-oriented processing trade industrial clusters have been severely impacted. With the country's gradual promotion of the transformation and upgrading of processing trade, the adjustment of regional economic structure and other related policies, and the gradual increase of the cost of the supply side of the industry, the transformation and upgrading have become the theme of the development of the Pearl River Delta industry. And therefore, cities in the Pearl River Delta not only need to transform traditional urban centers, but also need to start development and construction work in emerging areas, in order to achieve higher quality urban development and investment accumulation [2].

For Hong Kong and Macao, the problem of relatively inadequate land resources has become a shortcoming of urban development.

The Hong Kong government reviewed the needs of the New Territories New Development Area in 2007, hoping to meet the long-term housing and employment needs with the development of the New Area, and launched the "Planning and Engineering Research on the New Development Area of the Northeast New Territories" in 2008. This study has been largely completed in 2013. And the major land formation and infrastructure projects in the preliminary project plan will begin in 2018 to cope with the first residents in 2023.

According to the "Five-year Development Plan of the Macao Special Administrative Region (2016-2020)", the Macao government will simultaneously carry out two major tasks including

the reconstruction of the old area and the construction of the new city. The reconstruction of the old area will focus on the northern area of the Macau peninsula. The construction of the new city will focuse on Taipa and new reclamation area.

From 2011 to 2017, the average annual GDP growth rate of the Guangdong-Hong Kong-Macao Greater Bay Area was 8.45%, and the area of built-up areas expanded from 3,989.64km² to 4,635.06km², an increase of 645.42km². Regional economic activities will become more abundant in the future, which will promote the growing demand for land in this urban agglomeration. According to the latest published data, in 2018, the GDP of this bay area was 10,865.207 billion yuan, the total population was 71.1637 million, and the per capita regional GDP was 15,270 yuan, but both regional GDP and per capita regional GDP show significant differences, which indicates that although the economic growth level of this bay area is high, the quality of economic growth still needs to be improved, that is, the problem of differences in economic development between cities has yet to be resolved.

2.1. Development Goals

According to the Framework Agreement on Deepening Guangdong-Hong Kong-Macao Cooperation and Promoting the Construction of the Greater Bay Area, the planning and construction of the Guangdong-Hong Kong-Macao Greater Bay Area is of great strategic significance. It is a new thinking to maintain the prosperity and stability of Hong Kong and Macau and enrich the practice of "one country, two systems". It also is a new driving force to promote the integration of Hong Kong and Macau into the overall national development situation, integrate regional advantages, concentrate on participating in international competition, and promote the development of the "Belt and Road". Besides, it also is a new measure to intensify reform and realize the innovative mechanism and coordinated development of Guangdong, Hong Kong and Macao. According to the Outline of the Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area, the development and construction of this bay area must adhere to the strictest arable land protection system and the strictest land-saving system, promote the formation of green and low-carbon production, lifestyle and urban construction and operating model, provide residents with a good ecological environment and promote the sustainable development of the Greater Bay Area. It can be seen that the development goals of the Guangdong-Hong Kong-Macao Greater Bay Area include not only the requirements for regional economic growth, but also social development connotations such as creating a high-quality living circle [3].

3. FORECAST ANALYSIS OF LAND DEMAND IN GUANGDONG-HONG KONG-MACAO GREATER BAY AREA

3.1. Prediction of the Scale of Land in Built-Up Areas

3.1.1 Research methods and data

The gray system theory, for the uncertain system where some information is unknown, can find out the rules of the system's operation change through the acquisition and development of known information, and predict the system quantity at a certain time point in the future according to the system's evolution law. The basic model of the gray system theory is the GM (1,1) model. The GM (1,1) model has the common advantage of the gray prediction model, that is, it does not require a large sample to make predictions about the future changes of the system. At the same time, the GM (1,1) model is relatively simple to calculate and can make mid-to-long-term predictions. This set of advantages makes the GM (1,1) model widely used. Among them, the mean GM (1,1) model estimates the model parameters a and b based on the mean form of the GM (1,1) model, and constructs the GM (1,1) time response by solving the shadow equation [4].

The research data mainly used land data from the Statistical Yearbook of China's Urban Construction, the Hong Kong Statistical Yearbook, and the Macau Statistical Yearbook. Among them, the statistical indicator system of Hong Kong and Macao is different from that of the Mainland, so it lacks the indicator of built-up area.

However, the level of urbanization in Hong Kong is highly stable, which means the difference between the area of construction land and the area of built-up areas is not large; therefore, the area of construction land can be used instead of the area of built-up areas. Besides, the land area of Macao is small, which is not much different from the area of the built-up area; therefore, the total land area can be used to replace the area of the built-up area.

3.1.2 Research Process

The average GM (1,1) model is used to predict the area of built-up areas in the Guangdong-Hong Kong-Macao Greater Bay Area between 2011 and 2017 (see Table 1).

The mean form of GM (1,1) model: $x^{(0)}(k) + az^{(1)}(k) = b$. Substitute the original time series and the time series in the mean form, and use the OLS estimation method to obtain the model parameters a and b.

The shadow equation in mean form: $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$.

Its time response: $\hat{x}^{(1)}(k) = \left(x^{(0)}(1) - \frac{b}{a}\right)e^{-a(k-1)} + \frac{b}{a}, k = 1, 2, \cdots, n$.

Simulated values of raw data: $\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1), k = 2, 3, \cdots, n$.

Using DPS data processing system for data processing, we get the development coefficient -a = 0.025140, the gray effect amount b = 3,950.782619, the posterior ratio C = 0.1227, and the small error probability p = 1.0000.

According to relevant research experience in the application of the gray prediction model, when the development coefficient -a is less than 0.3, the model is effective for medium and long-term prediction. According to the model diagnosis, when the small error probability p is greater than 0.95 and the posterior ratio C is less than 0.35, the model is reliable. Based on this, it is predicted that by 2025, the built-up area of the Guangdong-Hong Kong-Macao Greater Bay Area will be 5,688.22 km².

Table 1. Regional GDP and built-up area of the Guangdong-Hong Kong-Macao Greater Bay Area in 2011-2017

Years	Regional GDP (100 million yuan)	Built-up area (km²)
2011	62,831.15	3,989.64
2012	67,888.28	4,115.48
2013	74,473.21	4,210.18
2014	79,946.03	4,263.39
2015	85,473.71	4,448.85
2016	93,401.36	4,563.97
2017	102,220.98	4,635.06

3.1. Analysis of Prediction Results

From the GDP and built-up area of the Guangdong-Hong Kong-Macao Greater Bay Area (see Table 1), it can be seen that there is a clear positive correlation between economic growth and built-up area. From 2011 to 2017, the GDP of this bay area increased by a total of 3,938.983 billion yuan, an average annual increase of 656.497 billion yuan, with an average annual growth rate of 8.45%. According to the scientific judgment of the national economic development, the Chinese economy has shown a new normal. The characteristics of development have changed

from high-speed growth to medium-high speed growth. It is expected that the average annual growth rate will slow down in the future. In terms of land demand, the built-up area in this urban agglomeration increased by 645.42km² from 2011 to 2017, with an average annual increase of 107.57km². According to the mean GM (1,1) model, the built-up area of this bay area by 2025 is predicted to be 5,688.22km², which means compared to 4,635.06km² in 2017, there will be an increase of 1,053.16km² and an average annual increase of 131.64km². The average annual increase in the built-up area from 2017 to 2025 is forecast to be 24.07 km² more than the average annual increase from 2011 to 2017. From the above analysis, it can be known that by 2025, the built-up area of the Guangdong-Hong Kong-Macao Greater Bay Area will reach 5,688.22km², and the newly built-up area will be 1,053.16km². This forecast result can generally meet the land demand for economic growth.

4. PREDICTION AND ANALYSIS OF LAND SUPPLY IN THE GUANGDONG-HONG KONG-MACAO GREATER BAY AREA

4.1. Research Methods and Data

Scientifically predicting the land supply status of the Guangdong-Hong Kong-Macao Greater Bay Area is, in its substantive sense, exploring the area of unused land suitable for development and construction. According to related research on land supply, factors such as terrain elevation, slope, and area of existing land will affect the land supply of a region. Considering that the Guangdong-Hong Kong-Macao Greater Bay Area is located on the southeast coast, the terrain is mostly hills and plains, and the overall terrain conditions are good. The influence of terrain elevation on the suitability of construction land can be ignored. According to the "Vertical Planning Standards for Urban and Rural Construction Land (CJJ 83-2016)", the planned slope of urban and rural construction land should be less than 25 degrees. Based on this, the calculation formula for the future land supply in the Guangdong-Hong Kong-Macao Greater Bay Area can be expressed as: the potential supply area of construction land is equal to the area of unused land with a slope of 25 degrees or less, and is also equal to the land area with a slope of 25 degrees or less minus the sum of the area of existing agricultural land, existing construction land and water body [5-6]. Among them, agricultural land includes farmland, forest and grassland.

The research data mainly uses the administrative division maps, ASTER GDEMV2 digital elevation data, land cover maps with a resolution of 30 meters in 2017, and the population data of Guangdong Statistical Yearbook, Hong Kong Statistical Monthly, and Macau Statistical Yearbook. Among them, the administrative division map comes from the National Geographic Information Resource Catalog Service System, the digital elevation data comes from the Geospatial Data Cloud Platform of the Computer Network Information Center of the Chinese Academy of Sciences, the land cover data comes from the Department of Earth System Science of Tsinghua University.

4.1. Research Process

Firstly, use ArcGIS to set the projection method of administrative division map to Lambert equiangular conic projection. The projection parameters are as follows: the central longitude is 113.5 degrees east, the first standard parallel is 22.5 degrees north, and the second standard parallel is 23.5 degrees north. The scale is 1 to 1.8 million. Use this set image as the research geographic basemap.

Secondly, the ASTER GDEMV2 digital elevation data was subjected to projection conversion, and the slope calculation was performed by grid surface analysis to generate a graded map of the slope of the Guangdong-Hong Kong-Macao Greater Bay Area (see Figure 1).

Thirdly, according to the land cover map with a resolution of 30 meters, the land use is divided into four types: agricultural land, water body, construction land, and unused land. The current status of land use in the Guangdong-Hong Kong-Macao Greater Bay Area is generated (see Figure 2).

Finally, the area tabulation is used to extract the unused land data of 11 cities whose terrain slope is not higher than 25 degrees to obtain the potential supply area of construction land in the Guangdong-Hong Kong-Macao Greater Bay Area (see Table 2).
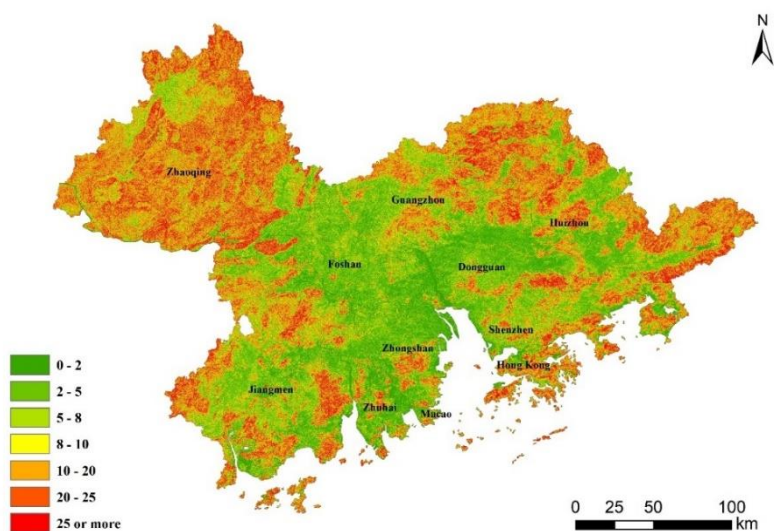
Figure 1. Slope classification of the Guangdong-Hong Kong-Macao Greater Bay Area
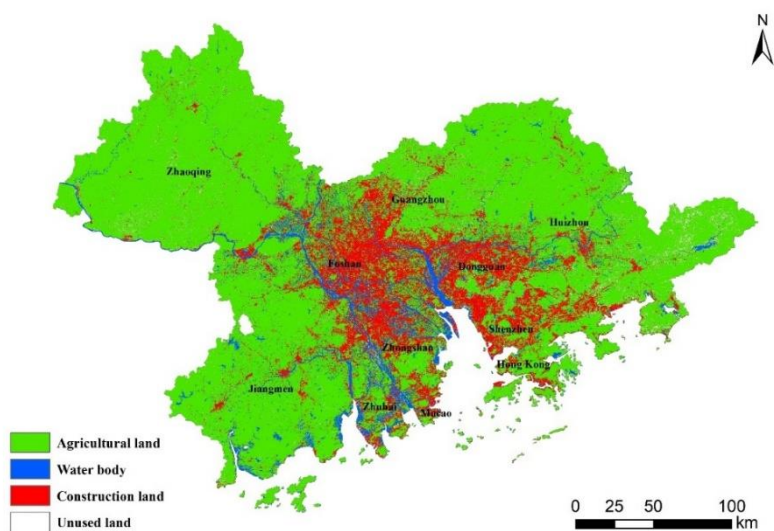
Figure 2. Status of land use in the Guangdong-Hong Kong-Macao Greater Bay Area

During the development and construction of the Guangdong-Hong Kong-Macao Greater Bay Area, not only the amount of unused land available for construction in the city should be considered, but also the local population. Calculate the ratio of the potential supply area of construction land to the population, and get the per capita new construction land area (see Table 3). On the one hand, cities with sufficient potential supply of construction land and a relatively small population should make use of the advantages of land resources and appropriately release more land to undertake engineering projects. On the other hand, cities

with insufficient potential supply of construction land and a large population should appropriately regulate its development efforts to carefully launch construction projects with less land, and tap the potential of its existing construction land to develop towards a compact city. By coordinating the land supply of each city and leveraging the resource endowment advantages of different cities, the sustainable, coordinated and healthy development of the Guangdong-Hong Kong-Macao Greater Bay Area will be achieved.

Table 2. Potential supply area of construction land in the Guangdong-Hong Kong-Macao Greater Bay Area

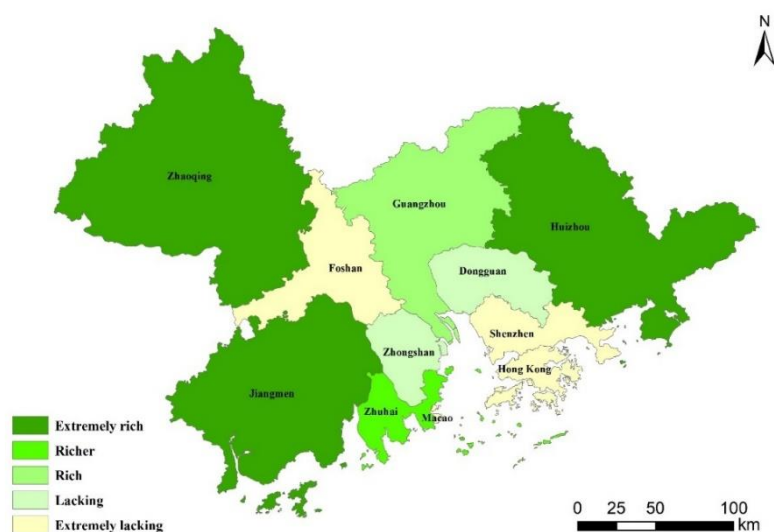| City	Potential supply area of construction land (m^2)	City	Potential supply area of construction land (m^2)
Guangzhou	186,855,827	**Jiangmen**	96,404,350
Shenzhen	35,238,511	**Huizhou**	429,785,735
Zhuhai	33,131,175	**Zhaoqing**	255,177,520
Foshan	31,191,708	**Hong Kong**	28,641,129
Dongguan	49,617,198	**Macao**	1,740,817
Zhongshan	19,682,426	**Total**	1,167,466,398

Table 3. New construction land per capita in the Guangdong-Hong Kong-Macao Greater Bay Area

City	New construction land per capita (m^2 / person)	City	New construction land per capita (m^2 / person)
Guangzhou	12.89	**Jiangmen**	21.13
Shenzhen	2.81	**Huizhou**	89.97
Zhuhai	18.77	**Zhaoqing**	62.01
Foshan	4.07	**Hong Kong**	3.86
Dongguan	5.95	**Macao**	2.67
Zhongshan	6.04	**Average**	16.78

Based on the per capita construction land area that can be added to cities in the Guangdong-Hong Kong-Macao Greater Bay Area, the land abundance grading standards for this bay area are determined (see Table 4). Based on the standard, the abundance of per capita newly-added construction land in this urban agglomeration is determined (see Figure 3).

Table 4. Land abundance grading standards for the Guangdong-Hong Kong-Macao Greater Bay Area

Land abundance type	Per capita increase of construction land (m^2 / person)
Extremely rich	≥20
Richer	15~20
Rich	10~15
Lacking	5~10
Extremely lacking	≤5

Figure 3. Land abundance classification in the Guangdong-Hong Kong-Macao Greater Bay Area

4.1. Analysis of Prediction Results

From the experimental results of ArcGIS, the potential supply area of construction land in the Guangdong-Hong Kong-Macao Greater Bay Area is predicted to be 1167.47km². Among them, Huizhou has the largest potential supply area for construction land, Zhaoqing is the second, Guangzhou is the third, and Macau has the least. According to relevant statistics, in terms of population, Guangzhou is the city with the largest population in this bay area, followed by Shenzhen and Dongguan, and Macau is the least. Based on the population and the potential supply of construction land in each city of this urban agglomeration, calculate the per capita new construction land. It can be predicted that Huizhou has the largest new construction land area per person, followed by Zhaoqing and Jiangmen, and Macau has the least. According to the land abundance grading standards for this bay area (see Table 4), Huizhou, Zhaoqing and Jiangmen can add a lot of new construction land per capita, followed by Zhuhai, while Foshan, Hong Kong, Shenzhen and Macau almost impossible to increase.

5. ANALYSIS OF THE COORDINATED DEVELOPMENT PATTERN OF LAND SUPPLY AND DEMAND IN THE GUANGDONG-HONG KONG-MACAO GREATER BAY AREA

In order to achieve a healthy pattern of coordinated development of land supply and demand in the Guangdong-Hong Kong-Macao Greater Bay Area, we should coordinate regional development and construction, make good use of the above-ground and underground space, strengthen inter-city cooperation and industrial linkage, and promote sustainable and healthy development of this urban agglomeration under the balance of land supply and demand.

5.1. Improve the Spatial Layout of Land Resource Construction and Utilization

According to the forecast of land supply and demand in the Guangdong-Hong Kong-Macao Greater Bay Area, the completed area of this bay area will reach 5,688.22 km² in 2025, an increase of 1,053.16 km² compared to 4,635.06 km² in 2017, and its potential supply of construction land is 1,167.47km². According to the analysis of the results, it is found that by 2025, the total potential supply of construction land in this urban agglomeration can basically meet the needs of the expansion of the built-up area. However, in terms of the land supply and demand of cities in this bay area, the differences between the cities are obvious, and there are

structural contradictions, that is, land supply and demand contradictions have been outstanding in some cities. Therefore, according to the actual conditions of land supply and demand in cities in this urban agglomeration, the spatial arrangement and timing of land resource construction and utilization need to be improved in the spatial layout of regional development.

According to the potential supply area of construction land (see Table 2), the per capita new construction land area (see Table 3) and the land abundance classification (see Figure 3), in the Guangdong-Hong Kong-Macao Greater Bay Area, the potential supply of construction land in Huizhou, Zhaoqing, and Jiangmen is relatively large. At the same time, these three cities have relatively small permanent residents, so the potential supply of per capita construction land in the three cities is extremely rich. In the future, these three cities can appropriately undertake more land resource development and construction projects.

The potential supply of construction land in Zhuhai is not much, but the permanent resident population is small, so the potential supply of construction land per capita is rich. Foshan, Shenzhen, and Hong Kong are densely populated, and the potential supply of construction land is small, resulting in a lack of potential supply of per capita construction land. In the future, these three cities should focus on intensive land resource development. Macao and Zhongshan have smaller populations and the potential supply of construction land is less; and therefore, the potential supply of construction land per capita is lacking. In the future, regional cooperation should be used to expand space to make up for the shortfall in land supply.

5.2. Promote Regional Cooperation to Expand Land Use Space

Judging from the previous Guangdong-Hong Kong-Macao regional economic cooperation and the GDP data of cities in the Guangdong-Hong Kong-Macao Greater Bay Area, the cities along the Pearl River Estuary are the main cities leading the economic growth of this bay area. But with the continuous development of the economy, the potential supply of construction land in these cities will gradually decline. Therefore, the direction of future urban land resource development and construction should be shifted, that is, the spatial development of this urban agglomeration should be expanded from the coast of the Pearl River Estuary to the surrounding areas. In terms of spatial arrangement and timing arrangement, the construction land of this bay area should be tilted towards Zhaoqing, Jiangmen and Huizhou, that is, priority should be given to the eastern and western regions of this urban agglomeration with a large potential for construction land. Zhaoqing, Jiangmen, Huizhou, and Zhuhai have relatively low levels of economic growth and are less attractive to talents, funds, and other factors. However, these four cities all have a rich potential supply of construction land per capita, which means they can take advantage of land resources and undertake more land development projects through regional cooperation in the future [7]. In recent years, the Hengqin Campus of the University of Macau, the Guangdong- Macao Cooperative Industrial Park and the Daguang Bay Economic Zone have been put into planning and development. The completion of these cooperation platforms can not only expand the development space of Macao to make up for the shortcomings of the current urban development, but also help strengthen regional links to promote the rational allocation of regional resources.

5.3. Promote Infrastructure Connectivity Between Cities

The change of rengional land use pattern is closely related to the layout of traffic construction. The traffic development strategy guided by public transport is conducive to promoting regional connections and cooperation, enabling economic activities to be carried out in a wider range, and then helping to give full play to the resource endowment advantages of cities and optimize the spatial layout of this region [8]. Therefore, in order to realize the land use pattern of coordinated development of supply and demand in this bay area, it is necessary to promote the

interconnection of infrastructure between cities and build an efficient and convenient modern integrated transportation system. Based on the efficient and convenient transportation within this region, strengthen the connection and cooperation between cities along the Pearl River Estuary and cities in the east and west of this urban agglomeration, so as to give full play to the talent, capital, technical advantages of cities along the Pearl River Estuary and the advantages of land resources in eastern and western cities of this urban agglomeration, and then realize the effective allocation of regional resources.

5.4. Exploit the Potential of Existing Construction Land

Economic development that can only rely on new construction land is unsustainable. The land use method mainly based on extensional expansion can alleviate the contradiction between land supply and demand in a short period of time. However, with the economic development of the Guangdong-Hong Kong-Macao Greater Bay Area, the contradiction between limited land resources and unlimited land demand will become increasingly prominent. There is also a situation of low land use efficiency inside the old city. Therefore, in order to realize the sustainable and healthy economic development of this bay area and meet the people's needs for a better life, the potential of the existing construction land should be tapped to increase the intensity of intensive land use [9]. For cities with dense populations and scarce land resources, it is very important to implement a concentrated and compact urban development plan, which can curb the blind expansion of cities to a certain extent in specific practice.

In terms of industrial development, Shenzhen, Hong Kong and Macau should focus on the development of knowledge-intensive and productive service industries; and through the centralized setting and sustainable comprehensive use of public facilities [10], effectively save urban land and increase urban land benefit. At the same time, make good use of the above-ground and underground space, carry out the renovation of old areas in above-ground space, and develop underground space in places with better geological conditions. Although the reconstruction of the old district cannot increase the land area, the efficiency of land use can be improved by re-integrating and re-planning the land in the old urban area [11]. The orderly development of underground space will not only help to leave enough ground space for ecological construction, but also help drive the development of construction materials, machinery and equipment and construction and management industries, and ultimately achieve the creation of a high-quality living circle [12].

6. MAIN CONCLUSIONS

This study uses the grey prediction model mean GM (1,1) to forecast land demand in the Guangdong-Hong Kong-Macao Greater Bay Area, and uses ArcGIS to predict the potential supply of construction land in this bay area. Based on the forecast results of land supply and demand, the paper analyzed how to promote the coordinated development pattern of land supply and demand in this urban agglomeration, and obtained the following conclusions:

First, the total potential supply of construction land in the Guangdong-Hong Kong-Macao Greater Bay Area is basically balanced with the demand for land expansion in the built-up area. According to the average GM (1,1) model, using the data of the built-up area of this bay area from 2011 to 2017, it is predicted that the built-up area of this urban agglomeration will be 5,688.22km² by 2025, an average annual increase of 131.64km². Using ArcGIS analysis, the potential supply of construction land in this bay area was 1,167.47km². According to the forecast results, the total potential supply of construction land in this urban agglomeration can basically meet the expansion needs of the built-up area.

Second, there is a structural contradiction in land supply and demand within the Guangdong-Hong Kong-Macao Greater Bay Area. The actual conditions of land supply and demand between

cities in this bay area are different, that is, the contradiction between land supply and demand is outstanding in some cities. Among them, the potential supply of construction land in Huizhou, Zhaoqing, and Jiangmen and its per capita volume are relatively abundant. Zhuhai has a relatively large amount of new construction land per capita, while Foshan, Hong Kong, Shenzhen and Macau have fewer.

Third, the Guangdong-Hong Kong-Macao Greater Bay Area should improve the layout of land development and construction in terms of space and timing arrangements. According to the actual situation of land supply and demand, the direction of land resource development and construction in this bay area should expand from the Pearl River Estuary to the surrounding areas. On the one hand, based on efficient and convenient transportation within this region, promote regional cooperation to expand land use space. On the other hand, a centralized and compact urban development plan should be implemented in this district to strengthen intensive land use.

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