

THE ANALYSIS AND EVALUATION OF DYNAMIC CHANGES ON LAND USE TYPES IN ZHANJIANG CITY BASED ON GIS

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ABSTRACT

The analysis and evaluation of the change of land use degree in each county area of Zhanjiang city from 2000 to 2020 and the revelation of its development law can provide a theoretical basis for the formulation of rational land development strategy and land use overall planning, which is of great significance for regional sustainable development and regional ecological environment protection. This paper studied the dynamic change and regional difference of land use degree in Zhanjiang city, and analyzed the change status and regional difference of land use degree by using the comprehensive index model of land use degree and the dynamic model of single land use degree. The results show that the urban construction area of Zhanjiang city has increased from 2000 to 2020, indicating that the urbanization and economic development of Zhanjiang city are on the rise during this period, but the economic situation of each county-level region presents unbalanced development, and the urbanization rate is at a low level. Meanwhile, we should coordinate the relationship between ecological land and construction land, and optimize the urban land use structure from the perspective of regional differences, so as to realize the high-quality development of urban economy.

KEYWORDS: *Land Classification; Geographic Information System (GIS); Land Use; Comprehensive Index of Land Use Degree; Dynamic Change*

INTRODUCTION

Land use is one of the main ways that human activities affect the natural environment and is the key research content of land change. Including land use degree of land use structure, layout, style, and the effects of the content of five aspects, among them, the land use degree mainly reflects the breadth and depth of land use, it not only reflects the land use in the nature of the land itself, but also reflects the comprehensive effect of human factors and natural environment factors. It is of great significance for regional sustainable development and regional ecological environment protection to carry out the evaluation of regional land use degree and reveal its development law and find the existing problems pertinently. With the development of the social economy, the degree of land use in Zhanjiang city has changed greatly. The analysis of the dynamic change of the degree of land use in Zhanjiang city is of profound practical significance to the formulation of reasonable land development strategy and the overall planning of land use at the county level.

OVERVIEW OF THE STUDY AREA

Zhanjiang is located in the south of mainland China and southwest of Guangdong, between 109° 40' -110° 58' E and 20° 13' -21° 57' N, including the whole Leizhou Peninsula and a part of the north of the Peninsula. East south China Sea, south qiongzhou Strait and Hainan Province face each other, west beibu Gulf, northwest and Guangxi Zhuang Autonomous

Region of Hepu, Bo Bai, Luchuan county adjacent, northeast and the province of Maoming Maonan district and Dianbai, Huazhou county border. Zhanjiang is located in the low latitude area south of the Tropic of Cancer, belonging to the tropical northern margin monsoon climate, adjusted by the Marine climate all year round, no cold in winter, no hot in summer, the annual average temperature is 22.7°C ~ 23.5°C, increasing from north to south, 1.5°C difference between north and south. The annual average rainfall is 1395.5 ~ 1723.1mm, and the annual average sunshine duration is 1714.8 ~ 2038.2h. Zhanjiang covers an area of 13,263 square kilometers, with 4 municipal districts, 2 counties and 3 county-level cities under its jurisdiction.

According to the seventh census data, as of midnight on November 1, 2020, the permanent population of Zhanjiang city is 6,981,236. In 2021, Zhanjiang's GDP reached 355.993 billion yuan, ranking 10th in Guangdong Province. Most of Zhanjiang's land consists of peninsulas and islands. The terrain is roughly high in the central axis, low on the east and west sides, high in the north and south and low in the middle, with gentle ups and downs, mostly plains and platforms. Shuangfengzhang (384 meters) in Lianjiang County in the north is the highest point. The city's total land area, plains accounted for 66%, hills 30.6%, mountain 3.4%. Land and water surface (including reservoirs, ponds, ponds and rivers) accounted for 6.4%. Zhanjiang has both tropical soil types and coastal soil distribution. There are 10 soil types in Zhanjiang, including lateritic red soil, latosol, coastal sandy soil, coastal saline swamp soil, coastal saline soil, tidal sand soil, swamp soil, volcanic ash soil, vegetable garden soil, paddy soil. Red soil is the most common soil in Zhanjiang. In this paper, Zhanjiang City of Guangdong Province is taken as an example, and the specific administrative divisions are shown in Figure 1.

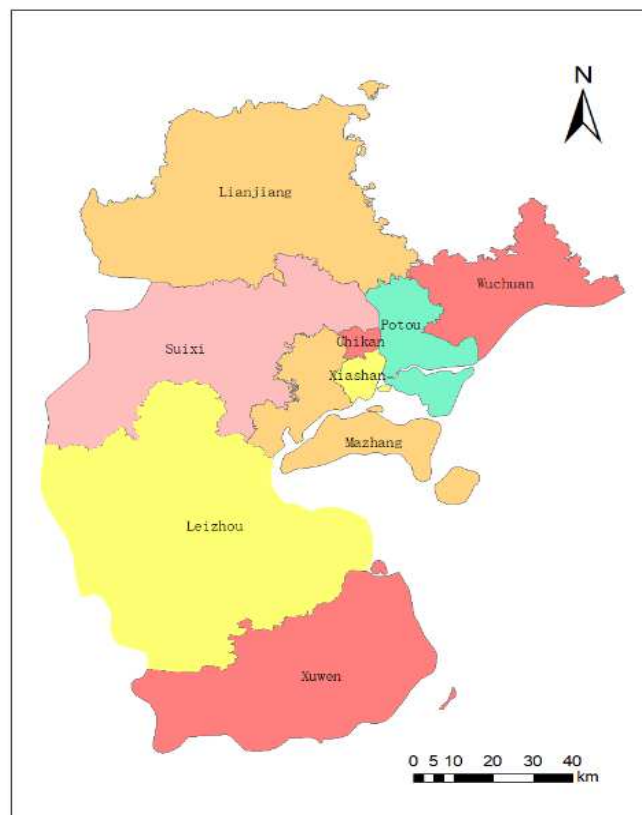


Figure 1: The Administrative Zoning Map of Zhanjiang City.

METHODOLOGY

Data Source and Processing

In this study, the Zhanjiang’s land use data from 2000 to 2020 are the global 30-meter land cover data (GlobeLand30) and the Zhanjiang’s administrative division data in Guangdong province in 2020. The data come from the platform of GlobeLand30: <http://www.globallandcover.com/>, and the geographical monitoring cloud platform: www.dsac.cn. This data is a 30m resolution raster data. Using ArcGIS10.1 software, the raster images of Zhanjiang district are extracted with mask extraction tool in extraction and analysis, and classified according to 8 first-level land use types. Finally, the land use type area of each county in 2000, 2010 and 2020 is calculated by area tabulation method in regional analysis.

All kinds of area data are statistically classified and summarized in Excel software to calculate the total area, proportion, rate of change and comprehensive index of land use degree of each county level land type and draw maps in Excel software (shown as figure 2). Through opening the attribute table of the vector layer of Zhanjiang administrative division in ArcGIS10.1 to connect the comprehensive index of land use degree, setting the quantity change in the symbol system, using the mapping function of ArcGIS10.1, the change map of the comprehensive index on land use degree of each county is derived.

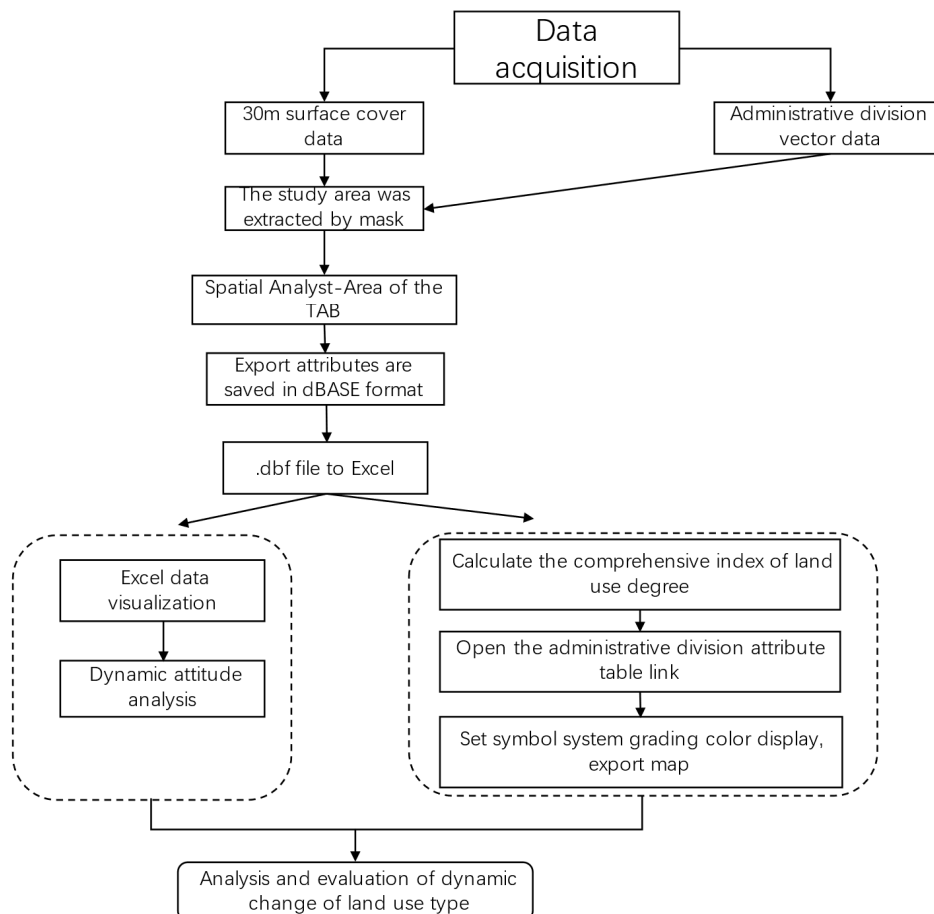


Figure 2: The Flowchart of Analysis.

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Data Calculation

Comprehensive Index of Land Use Degree

Comprehensive index of land use degree (L_a) is the overall level of land use intensification reflected by all land use types in a specific year. The comprehensive index of land use degree quantifies the impact of human activities on the land system through the classification of land use degree, and quantitatively describes the comprehensive level and change trend of land use in this region. It is an important index to measure the land use situation in a designated region. Its calculation formula is as follows:

$$L_a = 100 \times \sum_{i=1}^n (A_i \times C_i) \quad (1)$$

Type: L_a To study the comprehensive index of regional land use degree, $L_a \in (100, 400)$; A_i is the land use degree classification index, referring to the existing research results, unused land, bare land, no data =1; Woodland, grassland, shrub land, wetland and water =2; Cultivated land =3; Artificial surface =4; C_i is the area ratio of the corresponding ground class² (Shown as Table1). According to China's land classification rules, unused land is classified as: bare land, no data; Natural regeneration is divided into: woodland, grassland, wetland, water; Artificial regeneration is divided into: cultivated land; Construction land is divided into: artificial surface.

Table 1: The Hierarchical Assignment of Land Use Degree

State of the Land	Land Use Type	Grading Index
Unused land	Bare land, no data	1
Naturally regenerated	Woodland, grassland wetland, water	2
Artificially regenerated	Arable land	3
Construction land	Artificial surface	4

Analysis Method of Land Use Dynamic Degree

Land use change rate index refers to the change of unit area of land use type I from the beginning to the end of the study period, reflecting the dynamic intensity characteristics of different land use types. Its calculation formula is as follows:

$$K_i = \frac{LU_{it1} - LU_{it0}}{LU_{it}} \times \frac{1}{T} \quad (2)$$

Type: K_i is the change rate of a certain land use type during the study period; LU_{it0} and LU_{it1} denotes the area of land use type i of certain ecological land at the beginning and end of the study period. T is the research period².

ANALYSIS EVALUATION AND RESULTS

Evaluation and Analysis of Land Classification

The maps with 8 first-level land classification in Zhanjiang city from 2000 to 2020 were obtained by the re-classification tool in ArcGIS (shown as figure 3)³. As can be seen from the figure3, the land use types in Zhanjiang city are mainly cultivated land and forest land. Urban building land is mainly concentrated in the Chikan district and Xiashan District. Lianjiang city, Suixi County, Leizhou City, Xuwen County, Wuchuan city are distributed in the central city, but the overall urban construction area is relatively small.

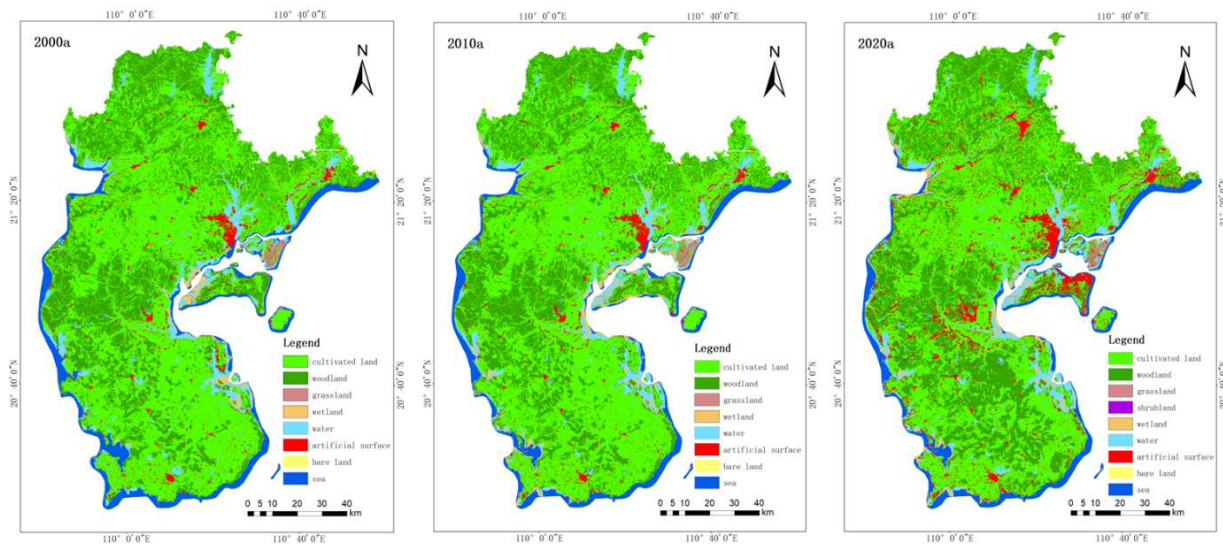


Figure 3: The Schematic Diagram of Land Use Types in Zhanjiang City from 2000 to 2020.

Land Use Comprehensive Degree Index Calculation

According to the values assigned in Table 1 and relevant land use data, formula (1) is used to calculate the comprehensive index of land use degree in 2000, 2010 and 2020 in Zhanjiang city and the dynamic change of land use degree in the region in the past 20 years (Shown as Table 2), and the specific distribution is shown in Figure 4.

Table 2: Change of Comprehensive Index of Land Use Degree in Zhanjiang city (Data Source: Globe Land30)

Administrative Areas	L ₂₀₀₀	L ₂₀₁₀	L ₂₀₂₀	ΔL ₂₀₀₀₋₂₀₂₀
Zhanjiang	253.70	255.46	257.02	3.33
Guangdong area	296.31	303.01	303.57	7.26
Chardonnay mountains	274.56	283.22	301.07	26.51
Potou area	240.92	245.65	247.55	6.63
Mazhang area	238.65	243.56	257.65	19.00
Shuixi	267.84	268.22	273.53	5.69
Xuwen	253.27	255.42	247.92	5.35
Lianjiang	252.90	253.58	258.34	5.45
Leizhou	251.88	253.63	251.49	0.38
Wuchuan city	249.06	250.25	254.51	5.46

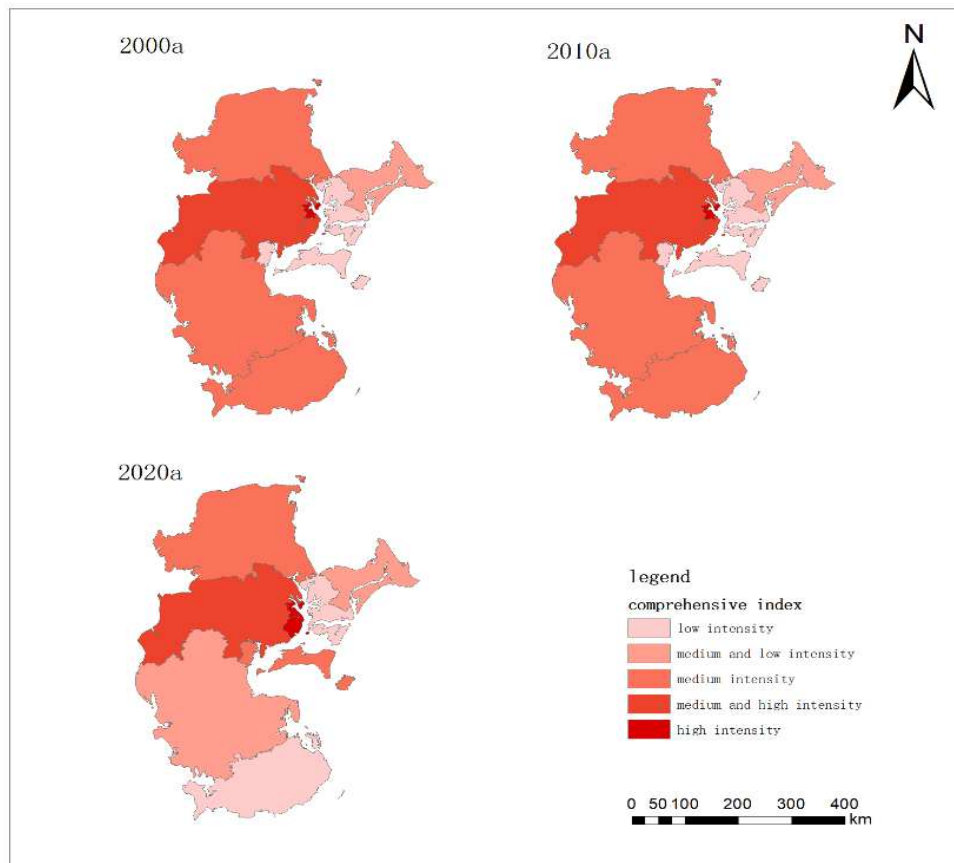


Figure 4: The Hierarchical Distribution of Comprehensive Index Changes of Land Use Degree in Zhanjiang City.

It can be seen from Table 2 and Figure 4 that the comprehensive index of land use degree in Zhanjiang city increased by 3.3 from 2000 to 2020. The comprehensive index of land use degree increased most significantly in Xiashan district and Mazhang District, with the change of 26.51 and 19.00, respectively, followed by Chikan District ($\Delta L_{2000-2020}$). The comprehensive index of Potou District, Suixi County, Lianjiang City and Wuchuan City has a relatively small variation range of 5.45-6.63. The comprehensive indexes of land use degree in Xuwen county and Leizhou city decreased, and Xuwen County was the most obvious one ($\Delta L_{2000-2020}$ The value is -5.35). In general, if ΔL_{b-a} is positive, the region is in the period of social and economic development; otherwise, it is in the period of decline and adjustment. But Zhanjiang is a farming, forest, fishing as the main industry region, arable land and forest land area of 80% in the city's total area of the land, the sum of the various counties on land use degree change value is closely related to the change of cultivated land and forest land area, cultivated land and forest land in leizhou, xuwen county land use types account for a large proportion.

The change of cultivated land and forestland area is related to the national policy of returning cultivated land to forest and grassland. Therefore, it is not generally considered that the change of the comprehensive index of land use degree in Leizhou city and Xuwen County is negative, and the level of economic development in these regions is in a period of decline. As the urban and village land, industrial and mining land, transportation land and other land types that really reflect the economic development status account for a small proportion in the whole city, its growth amount is not obvious in the change of the comprehensive index value. Thus, it is necessary to make a further analysis of the dynamic degree on the classes of Zhanjiang city⁴.

Dynamic Degree Analysis of Land Use

According to formula (2) of land use data, dynamic degree of various types of land use in Zhanjiang city from 2000 to 2020 are calculated (Shown as Table 3, Table 4), and the specific change trend is shown in Figure 5.

Table 3: Change Range of Land Use in Zhanjiang City from 2000 to 2020

Land Use Type	2000a		2010a		2020a	
	Area/km ²	Proportion / %	Area/km ²	Proportion / %	Area/km ²	Proportion / %
Arable Land	7296.16	54.08%	7405.07	54.88%	6556.50	48.59%
Woodland	3857.82	28.59%	3769.49	27.94%	3990.68	29.58%
Grassland	59.55	0.44%	51.07	0.38%	50.32	0.37%
Wetland	140.56	1.04%	253.40	1.88%	222.19	1.65%
The Water	830.57	6.16%	817.20	6.06%	910.55	6.75%
Artificial Ground	418.82	3.10%	424.47	3.15%	963.42	7.14%
Bare Land	3.75	0.03%	5.84	0.04%	6.91	0.05%
The Sea	885.13	6.56%	765.82	5.68%	782.60	5.80%

Table 4: Change Range of Land Use in Zhanjiang City from 2000 to 2020

Land Use Type	Magnitude of Change from 2000 to 2010		Magnitude of Change from 2010 to 2020	
	Area/km ²	Rate of change /%	Area/km ²	Rate of change /%
Arable land	108.92	0.81	848.58	6.29
woodland	88.33	0.65	221.18	1.64
grassland	8.48	0.06	0.75	0.01
wetland	112.84	0.84	31.21	0.23
The water	13.37	0.10	93.35	0.69
Artificial ground	5.64	0.04	538.96	3.99
Bare land	2.09	0.02	1.07	0.01
The sea	119.31	0.88	16.78	0.12

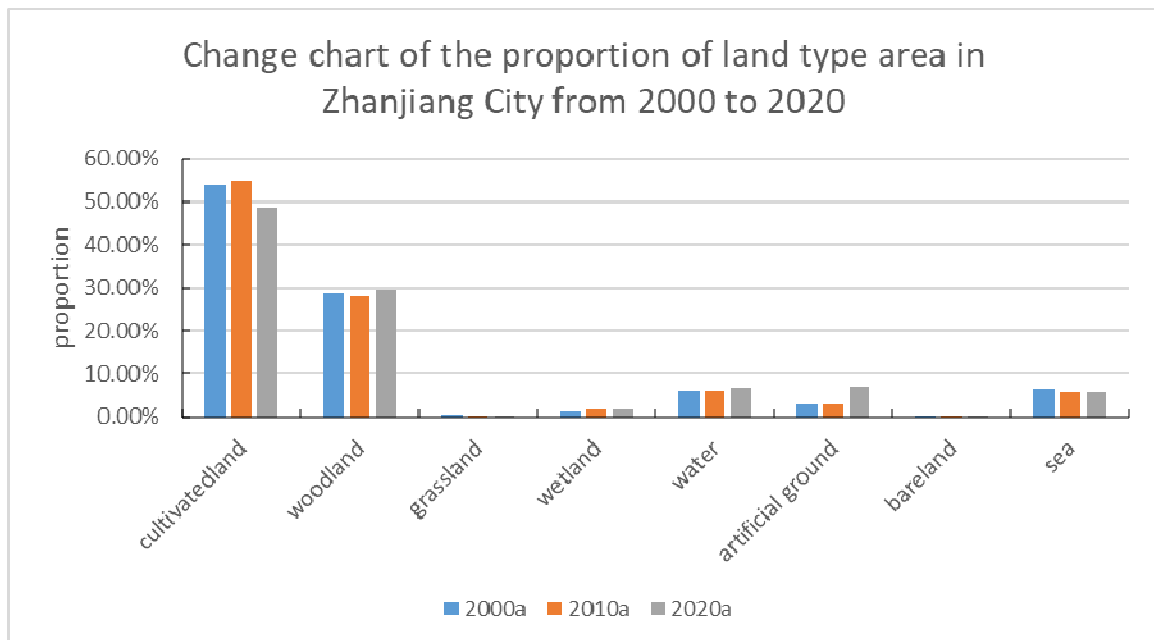


Figure 5: The Change of the Proportion on Land Type Area in Zhanjiang City from 2000 to 2020.

As can be seen from Table 3, in terms of the whole city, the change rate of cultivated land area, woodland area and artificial surface area from 2010 to 2020 is -6.29, 1.64 and 3.99, while the dynamic degree of other land use has little change, indicating that the urban building area has increased relative to that of 2000. In particular, the urban, village, industrial and mining land, which can truly reflect the level of urbanization and economic development of a region, has the largest growth, reaching 3.99. The area of man-made surface in all county-level areas has increased, indicating that the overall economic development level of the whole city is on the rise⁴.

County-Level Regional Analysis and Evaluation

In 2010, the land use composite index of Chikan District was the only county-level area that reached 303.01, and there was almost no change until 303.57 in 2020. Thus, before 2010, Chikan District had the largest urban construction area and was the central area of the whole Zhanjiang City (Shown as Figure 6). From 2010 to 2020, Xiashan district has the largest increase in the comprehensive index of land use degree and the largest proportion of urban construction area, becoming a new central city. From 2000 to 2020, the comprehensive index of Potou District ranges from 240 to 248. From an overall analysis, the economy develops slowly, and the growth of urban construction land area is at a low level in the whole city. From 2000 to 2020, the comprehensive index of Xuwen County and Leizhou city showed negative growth, but the urban construction area was in the stage of slow growth, which was closely related to its geographical location. Xuwen County and Leizhou City are located in the dense area of cultivated land and forest land in Zhanjiang City, and the area of cultivated land and forest land accounted for a large proportion, both over 70%, cannot conclude its economy appears negative growth phenomenon, actually economy grows somewhat. The urban construction area and economic status of Mazhang District, Suixi County, Lianjiang city and Wuchuan City have increased, and are in an upward trend, and mazhang District has the most obvious growth.

On the whole, the change of the comprehensive index of land use degree increased from 2000 to 2020, and the urban construction area was in a medium growth stage, indicating that the degree of land use increased year by year, and human activities had a greater impact on the change of LUCC⁵. Xiashan district is located in the center of the municipal district with the fastest growth rate and the largest comprehensive index growth, but its adjacent Potou district has a slow growth rate. Xiashan District and Chikan District should play a radiating role in the surrounding areas and drive the construction of the surrounding economy. According to the 12th and 13th Five-Year Plans of Guangdong Province, Guangdong will take the lead in building a moderately prosperous society in all respects and maintain medium-high economic growth with an average annual GDP growth of 7%. The average annual growth rate of Zhanjiang city is in the middle and low level of Guangdong Province, and the overall level needs to be improved. Zhanjiang is a city surrounded by the sea on three sides, so it can make full use of its geographical advantages, rationally develop the coastal landscape belt of the coastal city, and combine the marine tourism resources to drive the development of the local tertiary industry. Meanwhile, it should pay attention to the assessment of the risks on the ecological landscape to promote ecological balance and economic development⁶.

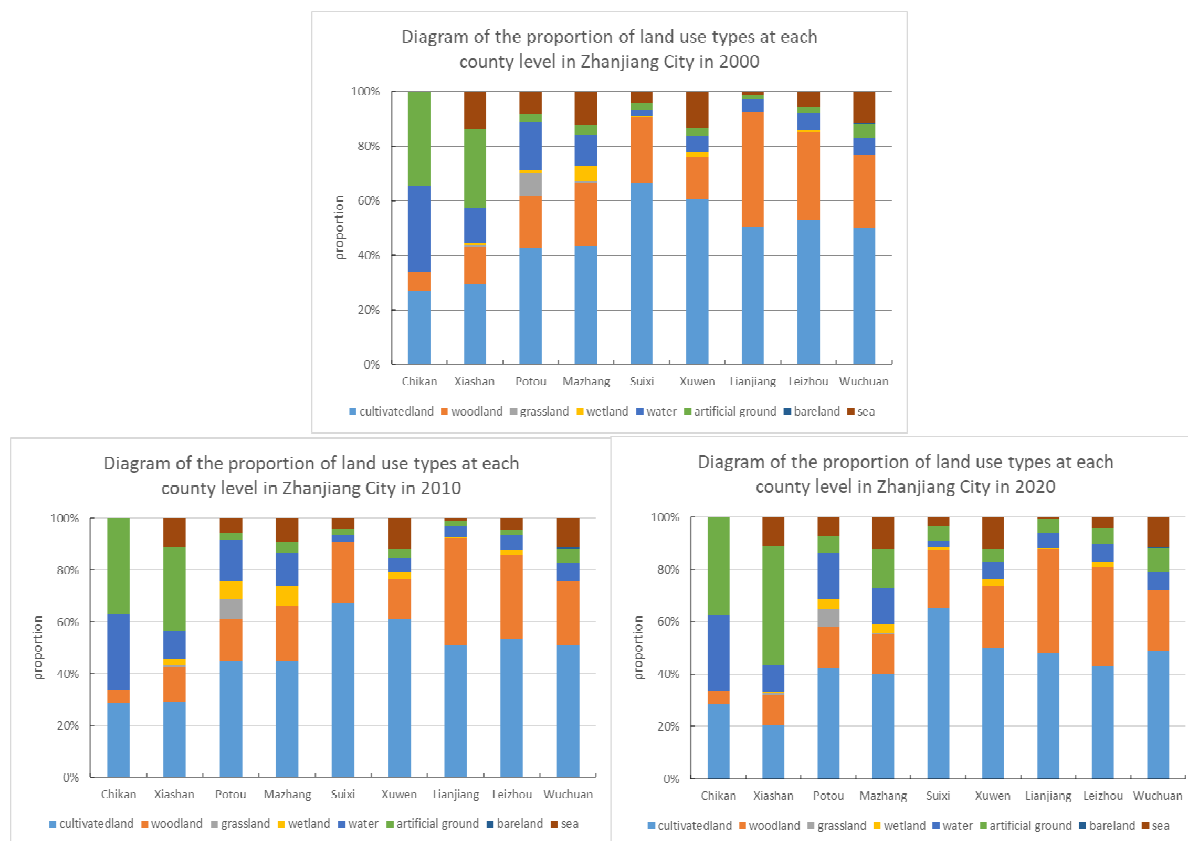


Figure 6: The Schematic Diagram of Proportion on Land Use Types in Different County-Level Areas of Zhanjiang City from 2000 to 2020.

CONCLUSION

Overall, the comprehensive index of land use degree in Zhanjiang has been increasing in the past 20 years, and the change of the comprehensive index on most county-level areas under the jurisdiction of Zhanjiang is also positive, except Xuwen county and Leizhou City. However, it cannot be simply considered that the economic development level of Xuwen County and Leizhou City is in a state of decline. Through the analysis of dynamic degree of land use, it can be seen that the growth of urban and village land, industrial and mining land and other land types, which really reflect the level of urbanization and economic development in a region, is large.

In addition, the dynamic degree of transportation land in the whole prefecture is also positive, indicating that the economic development level of the whole city is on the rise. However, enough attention should be paid to such phenomena as urban construction land occupation of cultivated land, grassland degradation and grassland area reduction. The change of various types on land use area affects the nature of land surface and the nature of underlying surface to a certain extent, resulting in the change and imbalance of local ecological environment [7,8]. While vigorously developing economy, we should coordinate the relationship between ecological land and construction land, optimize the urban land use structure from the perspective of regional differences, so as to realize the high-quality development of urban economy.

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REFERENCES

1. Feng, J., Li, X., and Wen, Q.(2020). Effects of land use change on the vulnerability of landscape pattern in Yulin City. *Science and technology management of land and resources*,037(003):25-36.
2. Wang, J., Hou, L., He, X., Liu, T., and Deng Y. (2020). Land use change and its ecological environment effect in Chengdu Plain Urban agglomeration from 2000 to 2019. *Bulletin of Soil and Water Conservation*,42(1):360-368.
3. Su, M., Zhang, W, Du, J. Li, M., Du, A., and Liang, Y. (2021). Dynamic change of LUCC in Shaanxi Province from 2010 to 2018. *Hubei Agricultural Sciences*, 5: 29-34.DOI : 10.14088/j.cnki.issn0439-8114.2021.05.006
4. Liu, P., and Dong, T. (2015). Regional Difference Analysis of Dynamic Change of Land Use Degree in Aba Prefecture. *Journal of Anhui Agricultural Sciences*, 43(14):3.
5. Liu, J., Zhang, C., Yu, Z., and Chen, D.(2020). Study on land use change and prediction based on Landsat image in Fuxian Lake Basin.*Journal of southwest forestry university*,040(003):131-138.
6. Zhang, W., Chang, W. J., Zhu, Z. C., Hui, Z. (2020). Landscape ecological risk assessment of Chinese coastal cities based on land use change. *Applied Geography*, 117(1): 102174. DOI:10.1016/j.apgeog.2020.102174
7. Wang, X., Yin, L., Honglin, M.A.,Dai, Z. and Zhang, X.(2021). The influence of change of land-use type on hydrological cycle. *IOP Conference Series: Earth and Environmental Science*, 671(1): 012041. DOI : 10.1088/1755-1315/671/1/012041
8. Yu, J. Q., Zhao, H., Wang, Y. T., & Xu, J. X. (2014). Evaluating Land Use Type Change and Ecosystem Services in Peixian County. In *Advanced Materials Research (Vols. 1065–1069, pp. 2744–2748)*. Trans Tech Publications, Ltd. <https://doi.org/10.4028/www.scientific.net/amr.1065-1069.2744>