ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

Sustainable land utilization, level assessment and spatial and temporal distribution characteristics analysis in the lower reaches of the Yangtze River

Tian Xingnan

School of Public Administration, Shanxi University of Finance and Economics, Taiyuan, 030006, China

Abstract: *It is significant to improve the sustainable land use level of urban agglomerations in the lower reaches of the Yangtze River. Based on the panel data of 26 prefecture-level cities in the middle and lower reaches of the Yangtze River from 2010 to 2020, the land sustainable use level assessment is studied. Therefore, this paper proposes some policy suggestions such as optimizing land resource allocation, strengthening land management laws and regulations, and implementing a regional cooperative development strategy. The research on the evaluation of the sustainable land utilization level in the lower reaches of the Yangtze River can provide a reference for further realizing high-quality development and optimization of ecological protection in the lower reaches of the Yangtze River, which is of great significance for the efficient and coordinated development and ecological security of China's land urban agglomeration.*

Keywords: *Lower Yangtze River urban agglomeration, Sustainable land use level, Spatial and temporal distribution characteristics*

1. Introduction

As an important carrier of social and economic development, urban agglomeration plays an important role in supporting the development of the lower reaches of the Yangtze River. The lower reaches of the Yangtze River is one of the most economically active regions in China. The urbanization of land resources in the lower reaches of the Yangtze River is an important engine to promote the economic development and social progress in the region. However, the urbanization process will certainly rely on the ultra-high intensity utilization of resources, which brings about a series of land resource utilization problems to be solved. In recent years, such as the shortage of land resources, the low efficiency of land resources utilization, land pollution and so on. The key to promoting high-quality development in the lower reaches of the Yangtze River lies in coordinating land use efficiency, economic development and ecological environment protection. Land use efficiency refers to the ability to achieve the maximum economic, social and environmental benefits through reasonable planning, management and utilization of a certain land area.

At present, the research on the evaluation of sustainable land use in domestic and foreign circles is constantly deepened. From the early evaluation of single resource utilization efficiency to the construction of a modern multi-dimensional and comprehensive evaluation system, the evaluation method and theory of sustainable land use have been constantly improved and developed. Foreign scholars started early in the evaluation of sustainable land use. For example, FAO (Food and Agriculture Organization of the United Nations) proposed the methodology of land evaluation in the 1970s, mainly from two aspects of the production potential and limiting factors of land. Subsequently, with the proposal and popularization of the concept of sustainable development, foreign scholars began to pay attention to the environmental and social impact of land use, and the evaluation indicators and methods were gradually enriched and improved. With the rapid development of economy and the acceleration of urbanization, the problem of sustainable land use has become increasingly prominent, which has attracted wide attention of scholars[1]. Domestic scholars' research on the evaluation of sustainable land use[2], not only pays attention to the production function of land, but also pays more attention to the ecological function and social function of land, and emphasizes the sustainability and versatility of land use[3]. In terms of evaluation methods, the traditional land sustainable use evaluation mainly adopts qualitative description and simple quantitative analysis, such as the use of land carrying capacity[4], and land productivity[5]. With the progress of science and technology, some new evaluation methods have been introduced into the evaluation of sustainable land use, such as the ecological footprint method[6], Life

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

cycle evaluation method[7]、GIS[8](GIS) technology[9]Make the evaluation results more scientific and accurate. In addition, the scale of sustainable[10] land use evaluation is also expanding, from the initial single plot evaluation to the evaluation of regional, river basin and even the national scale. At the same time, the dimension of the evaluation is also more comprehensive, including not only economic benefits, but also including ecological benefits, social benefits and other aspects, forming a comprehensive evaluation system[11].

In short, the evaluation of sustainable land use is a multi-disciplinary, multi-scale and multi-dimensional complex problem, which requires the comprehensive use of various theories and methods, combined with specific regional characteristics and social and economic conditions, scientific and reasonable evaluation and planning. In the future, with the advancement of global sustainable development goals and the application of new technologies, the research on the evaluation of sustainable land use will be more thorough and improved. Compared with studying a city alone, the study of urban agglomeration has more comprehensive and regional coordinated development advantages. An urban agglomeration is composed of multiple cities. By studying urban agglomeration, the mutual relationship and coordinated development of multiple cities can be comprehensively considered, including economy, transportation, environment and other aspects. This contributes to a more comprehensive understanding of the overall situation of regional development and develops policies and strategies to promote coordinated regional development. At the same time, many cities in urban agglomerations have a large scale in terms of economy and population, which may produce a stronger scale effect. Studying urban agglomerations can better analyze how this scale effect affects regional development. Therefore, the study of urban agglomeration is of great significance to promoting regional economic development, improving national economic competitiveness and promoting social harmonious development. So far, a large number of scholars have conducted various studies on the great river basin. For example, Wang Jinnan (2020) has studied the evolution of land use and landscape pattern in the Yellow River basin. Wu Hao (2019) have simulated the spatial and temporal evolution of land use with the Yangtze River Economic Belt as the research object. Many scholars have studied the landscape pattern and the evolution of hydrological events from the perspective of urban agglomeration, but most of their studies focus on the Yellow River basin and regional economic development, and there are few documents specializing in the evaluation of sustainable land utilization of urban agglomeration in the great river basin and not deep enough.

To sum up, the academic circle has carried out various studies on the big river basin, but there is still room for further exploration. On the one hand, with the determination of the strategic position in the lower reaches of the Yangtze River, land research in related areas increases, but most of them focus on economic development, water resources utilization in the basin, ecological efficiency and other aspects, and pay less attention to the evaluation of sustainable land use in the lower reaches of the Yangtze River. On the other hand, most of the studies on the lower reaches of the Yangtze River are based on the perspective of separate cities along the route, and there is not enough attention to the urban agglomeration in the lower reaches of the Yangtze River. Based on the ecological protection and the high-quality development of the major national development strategy background, combining the data of regional urban agglomeration from 2010 to 2020, this paper analyzes the sustainable utilization of the lower Yangtze River urban agglomeration, establishing the evaluation system of land regulation policy, to provide reference for improving the sustainable utilization of land in the lower Yangtze River urban agglomeration, to promote the development of urban agglomeration, boost the ecological protection of the urban agglomeration and high quality development of the lower reaches of the Yangtze River.

2. Index system and data analysis

2.1 Index system design

Considering the scientificity, rationality and data availability of the index system, this paper constructs the evaluation index system of sustainable land use by referring to the existing studies. For the evaluation target setting, the land sustainable and use level is evaluated as the first level target, and the second level target is set as the economic benefit and input of agricultural land and construction land. The sustainable utilization of land is affected by four aspects: resources, economy, ecology and environment. Therefore, the above four aspects should be included in the selection of indicators to make the input-output index system more complete (as shown in Table 1).① input index. Labor force and land are important input elements in the production function of neoclassical economics, so the area of urban construction land and the number of employed population at the end of the year are selected as the

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

characterization indicators. In addition, with the development of the economy and society, water resources and electricity energy have gradually become essential elements in people's production activities, so the consumption of water resources and electricity energy in the process of land use should be considered. This paper selects the total water consumption and electricity consumption of each city as the characterization index. For the use of water resources in agricultural land, the main evaluation index should consider the precipitation, which is more in line with the green use of natural resources and water cycle ② output index. According to the set secondary target, the agricultural land is mainly evaluated by economic benefits through grain output, but the environmental greening area should also be taken into account. Only in this way can it truly conform to the concept goal of sustainable green use of land in the national policy. This paper mainly studies the evaluation of sustainable utilization of land in the urban agglomeration, so the evaluation index of construction land includes the urbanization rate and the proportion of secondary industry. The evaluation of its total economic benefit is based on the economic output, namely the total GDP value and per capita GDP[12-13].

Table 1: Construction of the evaluation index system

Level 1 goal	Secondary objectives	evaluating indicator	unit
Evaluation of the sustainable land use level	Economic benefit and input of agricultural land	grain yield	Ten thousand tons
		precipitation	millimetre
		Environmental greening area	hectare
	Economic benefit and input of construction land	Labor input	thousands of people
		Water resources dosage	One hundred million cubic meters
		Electricity consumption	One hundred million kilowatt-hours
		The proportion of secondary industry	%
		Urbanization rate	%
		town site	square kilometer
	Total economic benefits	GDP total value	100 million
		per capita GDP	100 million

2.2 Entropy value method

For information theory, entropy is a measure of representing uncertainty. According to the characteristics of entropy, judge the degree of dispersion of an index. The greater the information, the smaller the uncertainty and the smaller the entropy; the greater the uncertainty and entropy value. In the comprehensive overview evaluation process, the entropy value method can effectively and objectively reflect the utility value of each index, and the entropy method is more reliable than the hierarchy analysis method and Ddlphi method. However, the concepts of logarithm and entropy are used in the determination of entropy weight, so that the negative value cannot directly participate in its calculation. Before the processing of index data, extreme difference standardization is often used to make corresponding treatment of some extreme values and certain regular translations to make it more reasonable. The formula is as follows:

For the positive indicator,

$$X'_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})} \tag{1}$$

For the negative indicator,

$$X'_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})} \tag{2}$$

To calculate the i-th index entropy value,

$$S_i = \frac{-(\sum M_i \times \ln M_i)}{\ln n}, M_i = X'_{ij} / \sum X'_{ij} \tag{3}$$

Where, SiIndicates the entropy value, MiIt represents the proportion of the i th sample, and n is the number of evaluated samples. Calculate the index weights.

$$W_i = (1 - S_i) / \sum (1 - S_i) \tag{4}$$

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

Finally, the comprehensive score of green development level of agriculture in each cities is calculated.

$$U_i = \sum W_i \times X'_{ij} \tag{5}$$

2.3 Data sources

This study is based on panel data related to the sustainable land utilization level in the middle and lower reaches of the Yangtze River from 2010 to 2020. A total of 26 cities in the middle and lower reaches of the Yangtze River were selected as the research objects. The data sources of the index system are mainly the statistical yearbooks of each city (2010-2020). Some missing data are obtained through the provincial statistical yearbooks and statistical bulletin, and the data panels of 26 cities in the middle and lower reaches of the Yangtze River from 2010 to 2020 are finally summarized.

3. Results analysis

3.1 Characteristics of timing evolution

The sustainable utilization of land resources is an important basis for ensuring national food security, promoting economic and social development and realizing ecological civilization construction. First of all, by establishing the index system and combining the previously found data, the proportion of the index system is determined by the entropy value determination method, and then the sustainable use of land is evaluated, the efficiency and sustainability of land use can be quantified and provide scientific basis for policy formulation and resource management. Time trend analysis of land sustainable use evaluation data obtained by entropy determination method.

The results show that the entropy of land sustainable use evaluation increased between 2010-2012 and 2012-2016 (as shown in Figure 1). This may be related to the importance and policy support of land resource management at the national level. Between 2010 and 2012, a series of land consolidation and agricultural support policies, combined with innovation and promotion of agricultural technology, improved the productive efficiency of land. In 2013 to 2016, the upward trend may be due to the sustainability and stability of policies, as well as increased environmental protection awareness and increased public participation. Together, these factors promote the overall improvement of land use efficiency and sustainability.

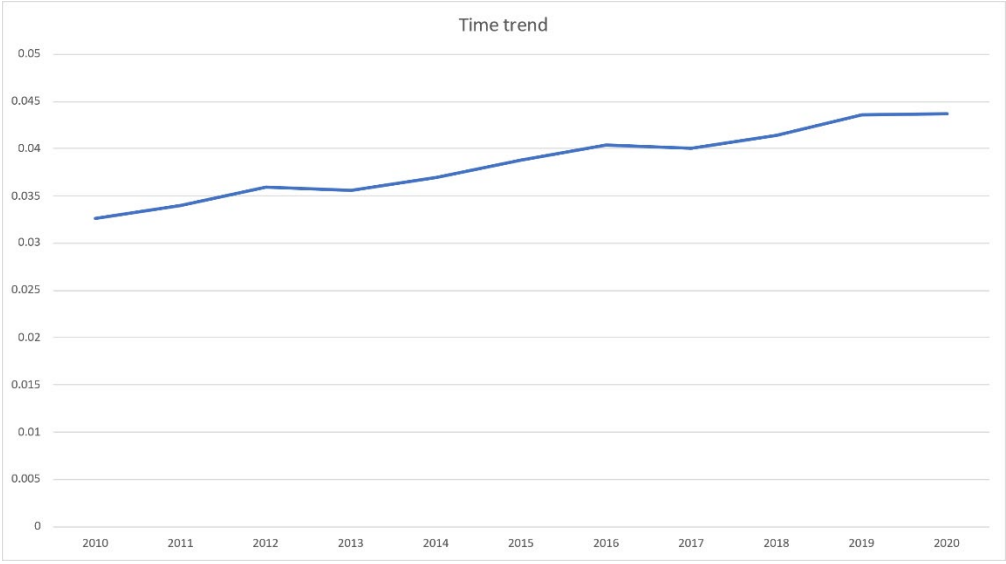

Figure 1: Time sequence evolution of sustainable land use

Instead, the entropy values decreased in the two time periods from 2012 to 2013 and 2016 to 2017. The decline in 2012 to 2013 may be related to factors such as economic fluctuations, policy adjustments, or natural disasters that may have contributed to short-term declines in land-use efficiency. In 2016 to 2017, the downward trend may be related to market changes, overexploitation of resources or other external shocks. These decline periods suggest that the stability of sustainable land use needs to be maintained through continuous monitoring and management, and the land use policy needs to be

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

evaluated and adjusted.

This may indicate that during this period, despite overall improvements, sustainable land use also faces increasing challenges, such as resource overexploitation, increased environmental pressures, and climate change. This period of slow growth may require more efforts to overcome the challenges, including strengthening the protection of land resources, promoting the green development of agriculture, and improving the efficiency of land use. In addition, long-term investment and planning for sustainable land use is also particularly important.

In conclusion, the sustainability of land use is influenced by many factors in different time periods, showing different changing trends. In order to realize the long-term sustainable utilization of land resources, comprehensive measures should be taken comprehensively considering various factors such as economic growth, environmental protection, technological innovation and social demand. This includes but is not limited to strengthening policy support, promoting agricultural technology innovation, raising environmental protection awareness, optimizing land resource allocation and enhancing public participation. Through these efforts, the sustainable use of land resources can be ensured to provide a solid foundation for the sustainable development of the economy and society.

3.2 Spatial evolution characteristics

3.2.1 Overview analysis

The calculation results show that the cities in the eastern region of the middle and lower reaches of the Yangtze River, such as Shanghai, Suzhou and Wuxi, have an outstanding performance in the level of sustainable land utilization, and generally rank at the top (as shown in Figure 2). This may be related to the level of economic development, urbanization process and relatively perfect land management and planning strategies of these cities.

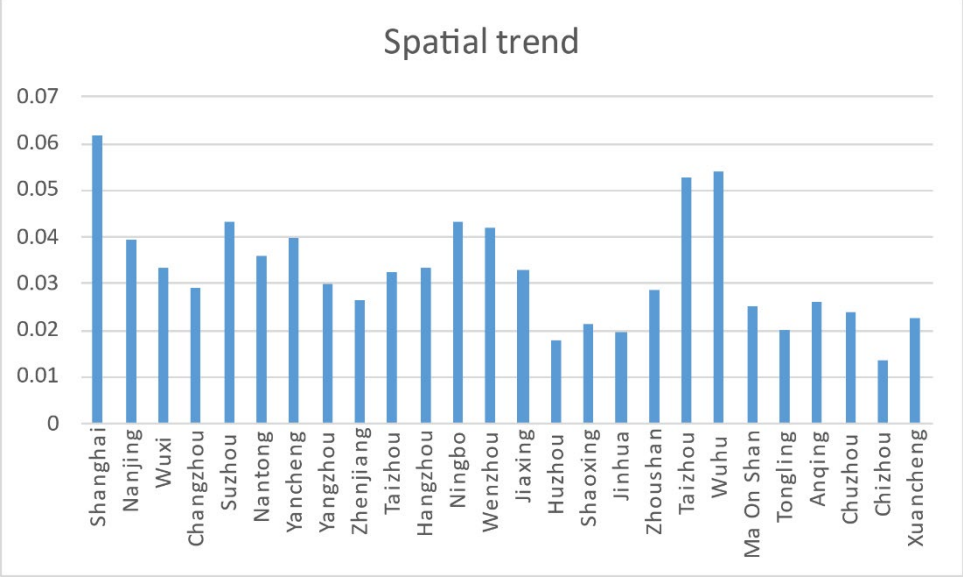

Figure 2: Space evolution of the sustainable use of the land

In addition, the investment and effectiveness of these cities in environmental protection and ecological construction may also play a positive role in improving the level of sustainable land use. In contrast, the cities located in the southern part of the urban agglomeration, such as Jinhua and Wenzhou, have a relatively low level of sustainable land use. This may be related to the high intensity of land resource use in these areas, the relative lack of measures for ecological and environmental protection and the lack of land use planning and management mechanisms in these areas.

It is worth noting that Taizhou city performs well in the southern region, and its sustainable land use level is second only to Wuhu city in the central region. The high ranking of Taizhou city is mainly due to its significant advantages in the environmental greening area, which indicates that the urban greening construction plays an important role in improving the level of sustainable land utilization.

To sum up, there are obvious spatial differences in the sustainable land utilization level in the urban agglomerations in the middle and lower reaches of the Yangtze River. The cities in the eastern region

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

perform well, while the cities in the southern region need to be improved. In particular, the advantage of environmental greening area in Taizhou plays a key role in improving the sustainable utilization level. This provides an important reference for the strategy formulation of sustainable use of urban land, that is, by strengthening urban planning, improving land use efficiency, strengthening ecological environment protection and promoting urban greening, the level of sustainable land use in urban agglomeration can be effectively improved.

3.2.2 Comparative analysis

A comparative analysis of the sustainable land use level in 2010 and 2020 in the middle and lower reaches of the Yangtze River can be made available. Although the overall ranking pattern remains relatively stable, the sustainable land use level of all cities has generally improved over the time span of ten years (as shown in Figure 3). Specifically, cities such as Huzhou, Shaoxing, Jinhua and Shanghai declined in the ranking of sustainable land use level. This phenomenon may be related to the shortage of land resources and the increasing ecological environment pressure faced by these cities in the process of rapid urbanization. On the other hand, cities such as Wuhu and Taizhou have risen in the ranking, which may be due to their active efforts in environmental protection and greening, as well as the effective management and utilization of hydropower resources.

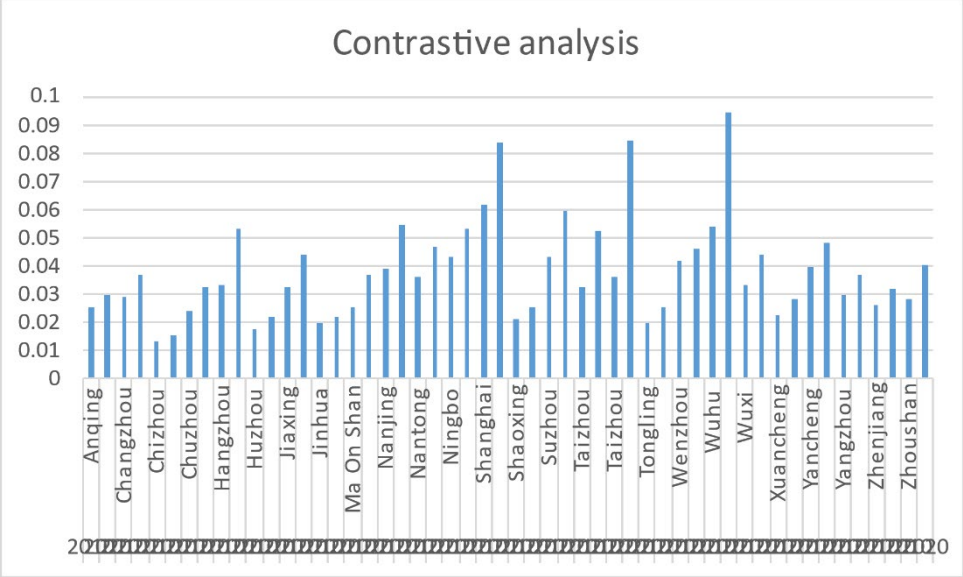

Figure 3: Comparative analysis of sustainable land use

The increase of environmental green area and the increase of per capita availability of hydropower resources not only directly enhance the ecological service value of land, but also reflect the strategic planning and policy orientation of these cities in sustainable development. In addition, the guidance of national policies, such as emphasizing environmental protection and promoting the economy into the new normal, namely from the pursuit of development speed to improving the quality and efficiency of development, also provides support for the sustainable use of urban land.

The analysis results show that the improvement of the sustainable use level of urban land is a complex process, which involves the coordinated development of economy, society and environment. With the rapid development of urbanization, how to balance the development and protection of land resources and how to achieve the win-win situation between economic and social development and ecological environment protection are the issues that need to be paid close attention to in the sustainable development of cities.

By comparing the sustainable land utilization level of the urban agglomerations in the middle and lower reaches of the Yangtze River in 2010 and 2020, it can be seen that although the overall sustainable land utilization level of the urban agglomerations has improved, there are different performances among different cities. Some cities have risen due to initiatives in environmental greening and resource management, while others may decline due to land resources and environmental pressures encountered during urbanization. This suggests that policy makers and urban planners need to consider economic, social, environmental and other factors and adopt diversified strategies to promote the sustainable use of land resources. At the same time, the policy guidance and support at the national level play an important role in guiding the cities to realize the sustainable use of land.

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

4. Conclusions and Discussion

4.1 Conclusion

Based on the panel data of 26 prefecture-level cities in the middle and lower reaches of the Yangtze River from 2010 to 2020, this paper calculates the sustainable utilization level of land for cities in urban agglomerations in the middle and lower reaches of the Yangtze River, and explores the spatial evolution and influencing factors from the temporal and spatial change trend, and obtains the following conclusions:

First, from the perspective of time change trend, the sustainable land utilization level in the lower reaches of the Yangtze River shows a fluctuating trend. This change trend reflects the positive efforts and achievements of national and local governments in land resource management policies, agricultural support policies and environmental protection in recent years. In particular, during the 2010-2012 and 2013-2016 time periods, the significant increase in the level of sustainable land use may be closely related to the strengthening of policy, technological progress and increased awareness of environmental protection.

Second, from the perspective of the spatial change trend, the sustainable land utilization level in the urban agglomeration in the lower reaches of the Yangtze River shows significant spatial heterogeneity in different regions. Eastern coastal cities, such as Shanghai and Suzhou, have a relatively high level of sustainable land utilization due to their developed economy, advanced land management and large investment in environmental protection. However, in some cities in the central and western regions, the relatively low level of sustainable land utilization is low due to the low efficiency of land resources utilization and imperfect environmental protection measures.

Third, from the comparative analysis, from 2010 to 2020, the relative ranking of sustainable land use level in various cities changed, but the overall pattern remained stable. Some cities, such as Wuhu and Taizhou, have achieved a significant improvement in the sustainable land utilization level by increasing environmental greening and hydropower resource management.

4.2 Policy recommendations

Based on the above conclusions, this study makes the following targeted policy recommendations:

1) Optimize the allocation of land resources: formulate scientific land use planning, optimize the allocation of land resources, improve the efficiency of land use, and ensure the reasonable development and sustainable utilization of land resources.

2) Strengthen land management laws and regulations: Strengthen the formulation and implementation of land management laws and regulations, strictly control the illegal occupation of cultivated land and the abuse of land resources, and ensure the legal and compliant use of land resources.

3) Promote land consolidation and restoration: increase the investment in land consolidation and ecological restoration, improve the land quality, enhance the ecological service function of land, and promote the sustainable utilization of land resources.

4) Promote land use technology innovation: Encourage the use of advanced land use technologies, such as precision agriculture and intelligent irrigation system, to improve agricultural production efficiency and reduce resource waste.

5) Strengthen environmental protection and greening: Improve the level of urban greening, strengthen ecological environment protection, improve the overall ecological environment quality of urban agglomeration, and enhance the ecological value of land resources.

6) Enhance public awareness of environmental protection: Through education and publicity activities, enhance the public awareness of the importance of sustainable use of land, and promote the participation of all sectors of society to participate in the protection and rational use of land resources.

7) Implement the regional coordinated development strategy: strengthen the coordinated development within the urban agglomeration in the lower reaches of the Yangtze River, realize resource sharing and complementary advantages, and promote the coordinated development of regional economy, society and environment.

ISSN 2616-5872 Vol.6, Issue 5: 23-30, DOI: 10.25236/AJEE.2024.060504

4.3 Research Limitations and future perspectives

This study has some limitations in data collection and model construction. Future studies can further expand the scope of the sample, include more social and economic factors, and adopt more advanced evaluation methods, in order to provide more comprehensive and in-depth decision support for the sustainable land use of urban agglomerations in the lower reaches of the Yangtze River.

Through the in-depth analysis and evaluation of this study, it is expected to provide scientific basis for land resource management, ecological protection and economic and social development of the urban agglomeration in the lower reaches of the Yangtze River, and promote the sustainable development of this region.

References

[1] Zhao Min. Evaluation study on sustainable land use in resource-based cities [D]. Anhui Agricultural University, 2022. DOI:10.26919/d.cnki.gannu.2022.000209.
[2] Deng Mei. Evaluation of sustainable land use in Chongqing [D]. Chongqing Normal University, 2021. DOI:10.27672/d.cnki.gcsfc.2021.000371.
[3] Zhang Xin. Evaluation and countermeasures on sustainable utilization of land resources in Chongqing [D]. Chongqing University, 2014.
[4] Zhu Xiuzhi. Research on the evaluation and prediction of comprehensive land carrying capacity [D]. Shandong Agricultural University, 2013.
[5] Jia-ping sun. Analysis of the ecological carrying capacity of land in Yushu City based on the ecological footprinting method [D]. Qinghai University for Nationalities, 2016.
[6] Xiao-lu zhang. Simplified life cycle evaluation method and its case study [D]. Guangdong University of Technology, 2013.
[7] Lu Xiaodong. Research on environmental carrying capacity based on GIS [D]. Shandong Jianzhu University, 2019.
[8] Song Zhigang. Research on sustainable Utilization and conservation of Land resources [D]. Inner Mongolia Normal University, 2013.
[9] Jiang Xiaoyu. Evaluation Study on Sustainable Utilization of Land Resources in Jiangsu Province [D]. China University of Mining and Technology, 2018.
[10] Hu Zhijuan. Study on comprehensive evaluation of sustainable Utilization of Land Resources in Hebei Province [D]. Shijiazhuang University of Economics, 2014.
[11] Zhao Lu. Spatiotemporal optimization of regional land use [D]. China University of Geosciences (Beijing), 2012.
[12] Yuan Lili. Study on the sustainable use of urban land in the urbanization process [D]. Huazhong Agricultural University, 2005.
[13] Chen Yanmei. Research on the evaluation index system of regional sustainable land use [D]. Northeast Agricultural University, 2005.