

Frontier Progress of Landscape Character Assessment in China

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Abstract The role of Landscape Character Assessment (LCA) at the level of territorial landscape governance spans both natural and social sciences. By analyzing the development history, research distribution, methods and applications of cutting-edge cases of LCA in China, the following conclusions are drawn: ① the LCA research in China originated earlier than that in Europe, but has not yet been systematically applied to the implementation of urban and rural planning at all levels; ② the fundamental theory of LCA in China has been well constructed, with three main research directions: technology-led, assessment-led, and assessment combined with other theories; ③ the development of LCA in rural areas is more mature than in urban areas, but the progress of research is uneven across regions; ④ the current research presents significant “bottom-up” academic characteristics, and there is an urgent need for government decision-making authorities and academia to jointly promote a “top-down” standardized governance mechanism to comprehensively promote the modernization of territorial landscape governance.

Keywords Landscape character assessment, Territorial landscape, Spatial planning, Standardized mechanism, Landscape governance modernization

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Landscape Character Assessment (LCA) is an effective governance tool validated nationally and internationally to provide technical support for integrated national landscape planning^[1-2]. LCA originated in the UK in the 1970s, and in the course of more than 50 years of development thereafter, LCA in the UK had been affirmed by the *European Landscape Convention*^[3]. Nowadays, countries such as the UK, France, Germany, Turkey, South Korea, and New Zealand have adopted the standardized mechanism of LCA for the effective management of territorial landscape^[4-7]. In China, the study on the landscape character of karst landforms in Guizhou in 1984 was the starting point for the study of landscape character^[8]. Subsequently, relevant studies were mainly found in the discipline of physical geography until the early 1990s, when the research objects shifted to

landscape elements^[9]. The related research applied to the governance of territorial landscapes began in 2006, and the research disciplines changed to landscape architecture, landscape and urban and rural planning^[10-15]. In 2019, the Ministry of Natural Resources issued the *Guidelines for the Construction of One Map for Territorial Spatial Planning*^[16] and other documents, and the new era and new requirements of the “one map” of territorial spatial planning^[17] have pointed out a new direction for the governance of territorial landscape. Scholars in this field agree that LCA is one of the important scientific tools for assisting China’s territorial spatial planning, including major strategies such as rural revitalization planning^[18-20].

1 Data statistics

By searching “landscape character” or key-

words containing “landscape character assessment” in China National Knowledge Infrastructure (CNKI), more than 700 papers from Chinese core journals, CSSCI and CSCD were obtained since 2000. Combing through the valid literature, it is found that the studies related to landscape character have shown an upward trend with undulating waves since the 21st century, with 2 peak phases of publication in 2010 and 2020. According to the distribution of keywords, it can be seen that the research on landscape character in China mainly focuses on “landscape pattern”, “landscape pattern character”, “landscape index”, “landscape type”, etc. (Figs.1-3).

The findings are as follows: firstly, the research object of LCA constantly tends to traditional villages and rural settlements; secondly, in addition to the keywords “landscape pattern”, “landscape index” and “land use”, “classification system”

Column introduction

Initiated by Yang Xin and Zhang Qi, the hosts of the RLncut research station, the City Observer column aims to observe the city we live in, measure the space we use, reveal the essence behind appearances and explore the source of vitality.

This article focuses on the frontiers of landscape character assessment in China, and analyzes the development history, research distribution, and cutting-edge cases of landscape character assessment in China, hoping to provide support for the integrated planning of territorial landscape in the later stages.

Yang Xin, Zhang Qi, the hosts of RLncut research station

and “rural landscape” also have obvious aggregation; thirdly, the clustering proportion of “urban landscape” is relatively small. “Landscape pattern”

appeared earlier than “landscape character”, and the proportion of “landscape character” research increased after 2004. The research on LCA of

“rural landscape” has been concentrated after 2010, and the targets have been gradually expanded to “rural planning”, “ecological network”, “rural revitalization” and so on. Rural landscape evaluation and protection also tends to be a research hotspot, in which VRM^[21] and VR^[22] techniques are used to study the visual evaluation of rural landscapes and landscape element preferences. The object of urban research is mainly a metropolitan study represented by Beijing, and the type of research focuses on theme parks, urban patterns, and so on.

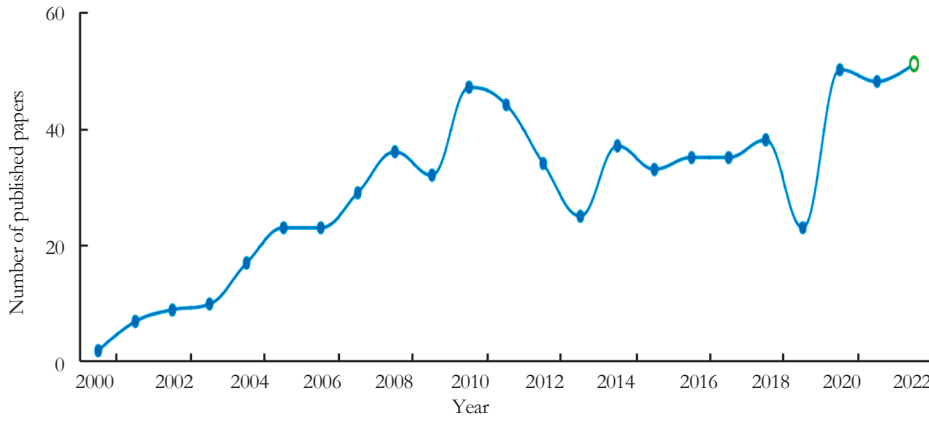


Fig.1 Visualization of trends in the number of articles issued

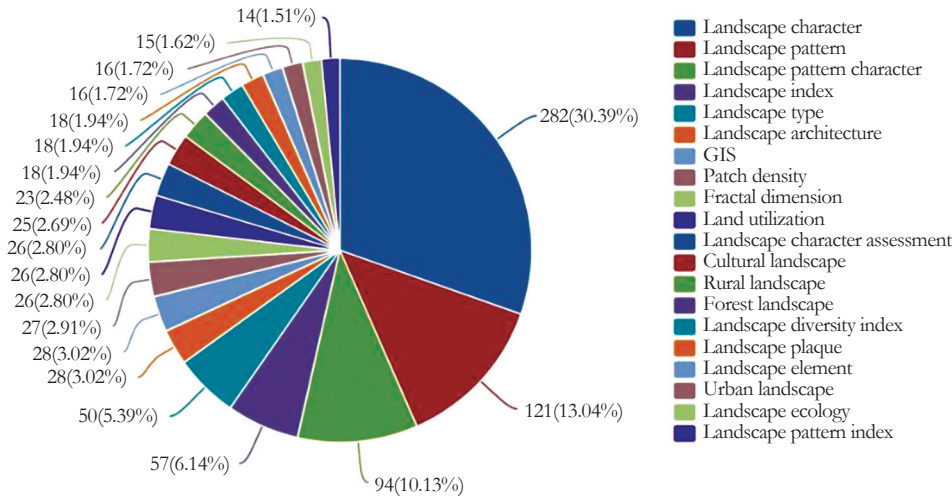


Fig.2 Distribution of keywords

Keywords	Year	Strength	Begin	End	1989–2002
Plaque	1989	2.61	2001	2006	█
Arid zone	1989	2.11	2003	2008	█
Evaluation	1989	1.94	2004	2006	█
Oasis	1989	2.25	2006	2008	█
Landscape pattern	1989	3.23	2007	2009	█
Dynamic change	1989	1.99	2007	2010	█
Danxia landform	1989	1.81	2007	2008	█
Nanjing	1989	1.72	2007	2008	█
Remote sensing	1989	5.89	2008	2011	█
Urbanization	1989	2.10	2008	2010	█
Agricultural landscape	1989	1.65	2008	2014	█
Land utilization	1989	3.84	2010	2012	█
Landscape	1989	3.48	2010	2015	█
Character	1989	2.92	2012	2013	█
Land cover	1989	1.62	2012	2013	█
Geographic name	1989	2.04	2014	2017	█
Cultural landscape	1989	3.46	2015	2022	█
Landscape gene	1989	2.50	2015	2020	█
Urbanization	1989	1.92	2015	2019	█
Traditional village	1989	3.14	2016	2022	█
Surface temperature	1989	2.07	2016	2022	█
Rural settlement	1989	1.89	2016	2020	█
National park	1989	3.49	2018	2022	█
Landscape architecture	1989	10.52	2019	2022	█
Traditional settlement	1989	2.10	2020	2022	█

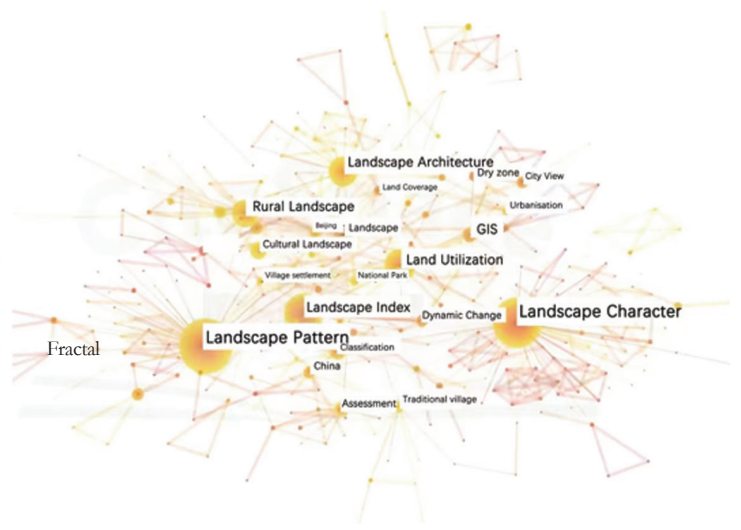


Fig.3 Top 25 keywords with the strongest citation bursts and keyword clustering analysis

character and emphasized the uniqueness of landscape types. In 2012, Lin Yanan^[11] proposed that landscape character is that each landscape area has its own personality. Wang Yuncai et al.^[12,28] proposed that landscape character refers to the factors within a certain site that make the landscape distinctive and produce site-specific feelings, and it is a special, recognizable form with consistent landscape elements that can distinguish one landscape from another. The above theories are the theoretical basis for the study of rural landscape character, the study of landscape character characterization system, and the study of landscape spatial unit recognition combined with artificial intelligence deep learning in the new period of China. Since 2015, Bao Ziting et al.^[2,13,29] have followed Carys Swanwick's definition of landscape character, and pointed out that LCA is an important tool for realizing landscape process management. This indicates that the academic research of LCA is developing and taking shape in China. In 2015, Zhao Runjiang et al.^[30-31] studied the Sanya countryside with LCA and proposed that the rural landscape character is the product of the continuous interaction between human beings and the natural environment in the rural area. In 2018, Zhang Hui et al.^[14] launched a relevant research on LCA and its application cases. Zhao Renjing et al.^[22] conducted a study based on China's territorial landscape planning and control system.

2.2 Distribution

The role of LCA at the level of territorial landscape governance spans both natural science and social science, involving natural resources, social culture, environment and economy. At present, there are more academic studies than practical applications on LCA in urban areas in China. The practice of applying the system

in urban and rural areas first occurred in the Hong Kong Special Administrative Region. The Hong Kong Municipal Planning Department (HKMPD) conducted a landscape delineation assessment with a basic unit of 5 hm² within the entire Hong Kong urban area, rural areas and watersheds, and established a landscape characterization map and database^[32]. Subsequently, the practical application areas mainly appeared in rural areas in eastern, northeastern and southern China. For example, Zhao Runjiang et al.^[30] evaluated landscape character and proposed landscape optimization strategies for rural areas in Sanya, Hainan Province. Liu Wenping et al.^[33] used GIS spatial analysis and a variety of quantitative statistical analyses to quantitatively cluster the landscape of Haidian District, Beijing, and evaluated the characteristics of urban and rural landscape types. Ma Yi et al.^[34] constructed a landscape evaluation framework combining regional-township domains based on landscape characterization research in 14 townships in Northeast China. Sun Qiaoyun et al.^[35] constructed a LCA method applicable to watershed ecosystems, and attempted to identify, map, categorize, describe and value the characteristic elements of the Qinghai Lake watershed.

We believe that the academic framework of LCA in China has been completed, but the application of "top-down" integrated governance throughout government, industry, university and research is seriously lagging behind. Typical application cases are concentrated in the geographical areas where the relevant research teams are located, with Hong Kong and Sanya on the southern coast as the first application demonstration areas. A known "top-down" integrated promotion effort took place in Hong Kong, where the Hong Kong Government consolidated landscape resources under its juris-

diction, established a unified assessment standard for centralized landscape governance, and modernized "holistic-partial" landscape governance with a standardized mechanism.

3 Case studies of cutting-edge advances

3.1 Research method cases

In the UK, where it originated, LCA has continued to accumulate governance experience in a standardized mechanism, providing information for researchers in various countries^[36]. Chinese scholars proposed to construct a multi-scale landscape character framework based on land, region, locality or place, identify and categorize the subjective and objective factors of landscape elements, and establish a database^[37]. Yang Diechuan^[38] conducted research at three levels: regional, place and local scales. Bao Ziting et al.^[39] optimized the classification of landscape features at various spatial scales and constructed a spatial control framework. Hu Haoze et al.^[40] took LCA as an auxiliary approach for rural planning and put forward opinions for rural development in combination with the overall territorial space planning. Currently, the research level of LCA in China is reflected in three major scales: the national and regional scale (1 : 250,000) corresponding to the entire territorial space region, the local authority scale (1 : 50,000 or 1 : 25,000) corresponding to the provincial and municipal administrative regions, and the local scale (1 : 10,000) corresponding to the county and township areas. The workflow consists of 2 stages and 6 steps. The first stage is the character mapping stage: ① confirmation of the research scope; ② preliminary information research to obtain landscape character zoning maps of different scales; ③ field investigation based on preliminary zoning map and construction

Table 1 Research techniques and theories of LCA in China since the 21st Century

Year	Scholar	Technological means					Research content							Research-integrated theory	
		RS	GIS	SPSS	Fragstats	CA-Markov	Landscape ecology	Landscape pattern	Landscape unit	Landscape index	Landscape assessment	Land cover	Spatial planning	AHP	C-3P
2023	Yan Jiaying		√					√	√		√		√		
2022	Wang Shuangao	√						√	√		√				
2022	Pan Yulian		√	√	√			√				√			
2022	Cai Wenting								√						√
2021	Bao Ziting	√	√								√		√		
2020	Biswajit Nath	√	√			√						√		√	
2020	Liu Yanlong		√				√				√			√	
2019	Su Kai	√				√	√	√							
2019	Fu Bo	√	√						√			√	√		
2019	Su Kai	√	√			√	√	√				√			
2015	Chen Yiling							√					√		√
2003	Wang Yuncai						√						√		
2003	Xie Hualin								√					√	

of research questionnaires; ④ Classification and description of landscape characters of different areas according to the previous data research and investigation results, drawing the final landscape character zoning map. The second stage is the assessment and judgment stage: ⑤ character assessment; ⑥ decision judgment. Based on the landscape character zoning map, recommendations are made for landscape planning improvements, landscape policies and strategies, design development and special projects. The main logic of LCA research in China is shown in Fig.4.

Several academic groups in China have constructed and improved their respective theoretical systems of LCA, and the development overview is shown in Table 1. Current research falls into 3 types of orientations: technology oriented, assessment oriented, and assessment integrated with other theories oriented. The preliminary stage of the study mainly adopts GIS and RS technology^[41-43], while the middle and late stages mainly include the construction of landscape character index system and the

implementation of LCA based on index system analysis. In these two types of studies, the establishment of an index system is a prerequisite for the implementation of evaluation^[44-45]. An independent theoretical evaluation system can be developed by combining geospatial landscape data, evaluation tools and other theories^[46-50].

3.2 Research content

Among many scientific research results on LCA, the two most representative cases in Guangdong and Beijing were selected for elaboration. The research team of South China University of Technology (SCUT) has focused on this direction for a long time, proposing that artificially defined administrative boundaries ignore the contextual relevance of ecological elements and landscape geography, and emphasizing the study of landscape character units across administrative boundaries. In the study of wetland landscape characteristics in 2023, a simple risk index model was used to construct a multi-scale wetland degradation risk assessment system based on grid and landscape character units, which integrated highly dispersed and fragmented

ecological patches through physical boundaries with manageability, and provided integrated ideas from human-land relationships, the recognition and understanding of the relationship between wetland elements and their surroundings, and the restoration of wetland degradation^[51]. In 2024, the team superimposed elements of geographic evolution zoning, land cover type, land use status and other features in the study of agricultural landscape characteristics in the alluvial region of the Pearl River Delta, and categorized scientific governance strategies for protection, renewal and maintenance for different types of agricultural landscapes^[52]. This type of research provides a high-value reference for relevant practitioners, is applicable and not limited to empirical studies by landscape scholars, and can provide scientific management ideas for decision-making authorities such as natural resource management.

Another case study selected a case in which the author's team proposed a framework for the governance of territorial landscapes in 2023, taking the shallow mountainous areas of Beijing as an example (Fig.5)^[53]. The study adopted

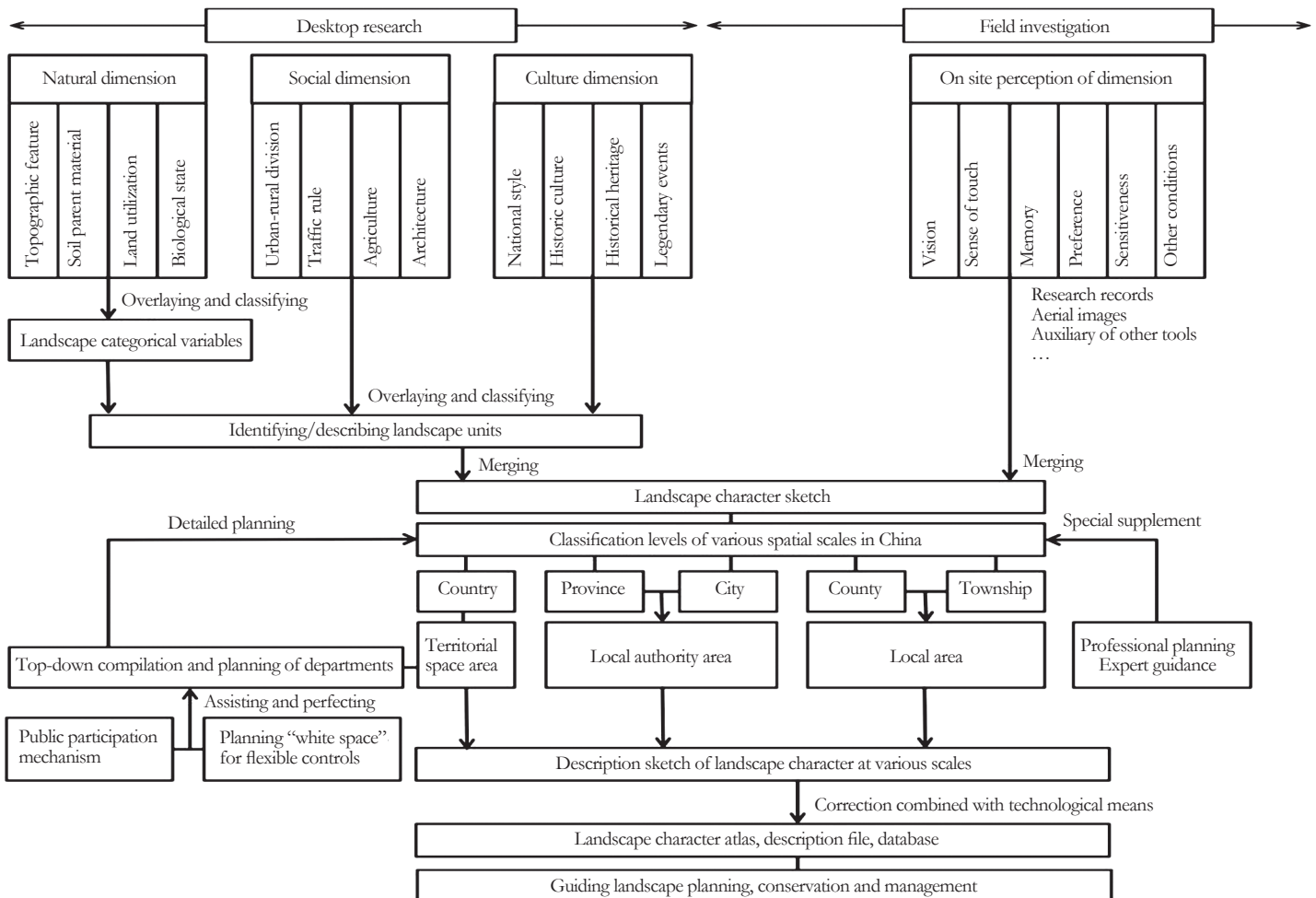


Fig.4 Main logic of LCA research in China^[39-40]

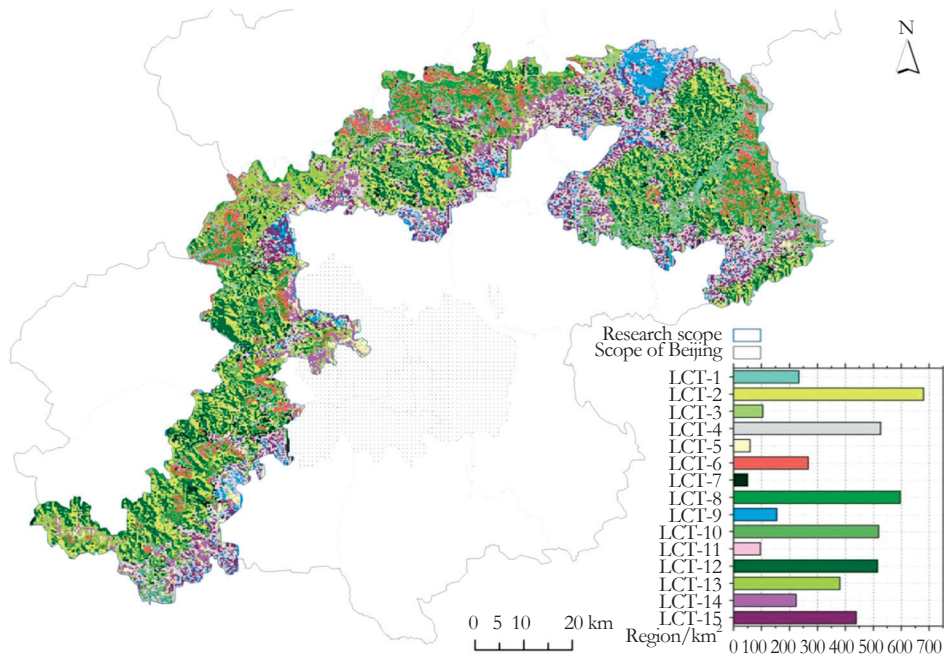


Fig.5 Landscape character classification and landscape character region of shallow mountain areas in Beijing

a parametric method to classify and partition landscape features; obtained landscape character types (LCT) through principal component analysis and second-order cluster analysis; then identified the contours of landscape character areas; used matrix transfer method to conduct an integrated assessment of landscape features and visual sensitivity; and finally, completed the analysis of landscape character protection types by adopting a multi-expert decision-making process in combination with landscape sensitivity assessment and field survey results, and formulated five strategies for different landscape character areas, including conservation, enhanced management, ecological restoration, innovative development and comprehensive enhancement. Taking shallow mountainous areas as an example, the study provided integrated territorial landscape governance ideas and tried to propose a methodology for character recognition and in-situ protection of areas rich in natural culture.

4 Conclusions

From the recognition of the importance of LCA tools by research teams in the early 21st century, to the first promulgation of official landscape character maps and implementation of standardized landscape governance in Hong Kong Special Administrative Region, and to the application cases represented by Guangdong and Beijing in recent years, the development in the past 20 years has made scholars in China unanimously agree that LCA has brought

brand new revelations to the construction of territorial landscape governance. Constructing a standardized mechanism for LCA with Chinese characteristics is a direction to assist territorial spatial planning to achieve sustainable development of natural resources in the whole region. Currently, the “bottom-up” academic research is well developed, but the “top-down” standardization mechanism of local governments has not yet been formed. This requires the organic combination of natural resources and development decision-making departments and academic circles to collaboratively promote the cutting-edge practice of territorial landscape governance, so that LCA can play a standardized and coordinated role in the development of beautiful China, and comprehensively promote the modernization of territorial landscape governance.

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