

ORIGINAL RESEARCH ARTICLE

Construction of evaluation index system of ecological civilized city

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ABSTRACT

Ecological civilization city evaluation is the driving force and main means to promote the construction of urban ecological civilization. The establishment of evaluation index system is the key to the scientific and accuracy of ecological civilization city evaluation. The element structure method is adopted to build the evaluation index model according to the functions of urban government in economy, culture, society and environment. Build an evaluation index system for urban ecological economy, ecological culture, ecological society and ecological environment.

Keywords: ecological civilization; city; government functions; evaluation indicators

1. Introduction

Researching and implementing the planning and construction of ecologically civilized cities is the goal of urban development in the 21st century. Promoting ecologically civilized urban planning through evaluation is an effective means to solve modern urban problems and achieve sustainable urban development. This is not only the requirement of the report of the 18th National Congress on the construction of ecological civilization, but also the result of seeking the sustainable development of the world and all mankind, but also the result of seeking the harmonious coexistence of human beings, society and nature. Therefore, studying the evaluation index system of ecological civilized city has become an important means to promote the construction of ecological civilized city.

2. Connotation of ecological civilization city evaluation

O. Yanitsky, an urban ecologist of the former Soviet Union, believes that eco city is the full integration of technology and nature, the maximum play of human creativity and productivity, and the maximum protection of residents' physical and mental health and environmental quality^[1].

Wu, a famous expert in China, put forward the theory that the city is a social, economic, natural and ecological complex ecosystem^[2]. Wang and others believe that urban ecosystem is gradually formed by the interaction between man and nature, and man is the driving force and resistance of urban development. In the urban ecosystem, a series of economic and social activities carried out by human beings to meet the needs of their own devel-

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opment maintain continuous input and output of energy flow and logistics with the natural ecosystem. The natural ecosystem responds to this input and output in various forms at the same time, so as to maximize the benefits of the system itself^[3]. Wang believes that eco city refers to using the principles of ecological economics and system engineering methods to change the mode of production and consumption, decision-making and management methods of the city, tap all available resource potentials inside and outside the city, and build a sustainable development community with economic efficiency, social harmony and ecological security within the carrying capacity of the ecosystem^[4].

To sum up, this paper believes that an ecological civilized city is an ideal residential city with economic development, cultural prosperity, social harmony and ecological environment, which regards the city as a composite system of “economy society culture environment” and uses the theoretical method of system science to plan and design an ideal residential city with economic development, cultural prosperity, social harmony and ecological environment. As pointed out in the report of the 18th CPC National Congress, we must thoroughly implement the scientific outlook on development, comprehensively implement economic construction, political construction, cultural construction, social construction and ecological civilization construction, and constantly explore the civilized development path of production development, affluent life and good ecology.

The evaluation of ecological civilization city is to build a scientific and operable index system according to the requirements of ecological civilization city, comprehensively judge the construction degree of urban ecological economy, ecological culture, ecological society and ecological environment, and comprehensively measure the ability of urban government to build ecological civilization.

3. Research status of ecological civilization city evaluation index system

The evaluation index system of ecological civilization city is composed of a series of indicators with internal connections, including the basic appearance of urban ecological economy, ecological culture, ecological society and ecological environment, coordinating the relationship between man and nature, man and man, man and society, man and himself in harmony, virtuous circle, all-round development and sustainable prosperity, and comprehensively monitoring the development of economy, politics, culture, society and environment. Comprehensively analyze, study and effectively manage major ecological problems in urban development to ensure the coordinated and sustainable development of urban economy, politics, culture, society and environment. Therefore, we must sum up experience and establish a set of scientific theories and index system suitable for the construction of ecological civilized cities according to China’s national conditions.

Since ecological civilization is the first in China, there is no concept of ecological civilization abroad, so it will not be repeated here.

The domestic research on how to build the evaluation index system of ecological civilization city is still in the preliminary stage, mainly from two angles. One is to construct the index system from the perspective of system theory, such as Qin’s construction from five levels: ecological economic civilization, ecological social civilization, ecological environmental civilization, ecological cultural civilization and ecological system civilization^[5]. Sun explored the connotation of ecological civilization city and considered it from five aspects: culture, society, economy, environment and human settlement, so as to build an urban ecological civilization evaluation index system with urban ecological culture as the core and advanced culture, social progress and economic development as the goal^[6]. Wang and others build five units of the relationship between ecological environment, ecological material civilization, ecological political civilization, ecological spiritual civilization and the outside of the region^[7]. Ma uses the five laws coordination theory to “inte-

grate social ecology, economic ecology, residential ecology and transportation ecology^[8]. The other is constructed from the perspective of element classification. For example, Shen divides the index system into ecological economy, ecological environment, improvement of people's livelihood, infrastructure, ecological culture, integrity and efficiency and other elements for the construction of Guiyang ecological city^[9]. Zhu calculates the ecological development index by constructing four dimensions of water environment, atmospheric environment, soil environment and other environment, and then predicts the development degree of China's ecological civilization^[10].

The research on the evaluation index system of ecological civilized cities in China has only been concerned in recent years and has not formed a unified understanding. At present, there are no experts to build the evaluation index system from the perspective of government functions. This paper is only an attempt.

4. Construction and design of evaluation index system model of ecological civilized city

The construction of ecological civilized city evaluation index system is a highly technical work, which requires the use of scientific methods, advanced technologies and means to ensure the comprehensiveness and scientific of the evaluation index, and to avoid the deviation in the index design and the improper influence of the designer's personal preference on the selection of the index.

The construction of an ecological and civilized city is a public responsibility jointly undertaken by the government, enterprises, social organizations and urban residents. Among them, the urban government bears the main responsibility, that is, the responsibility of the urban government. According to the requirements put forward in the report of the 18th CPC National Congress and the characteristics of urban government, the functions of urban government are mainly reflected in the construction of

ecological civilization in economy, culture, society and environment. Therefore, in the construction of ecological civilization city, the urban government pays attention to internal management and external effects, quantity and quality, economy culture society environment and other factors, so as to maximize the urban ecological civilization. Therefore, the element structure method is adopted to comprehensively reflect the level of ecological civilization city.

The so-called element structure method is to build the evaluation index system model according to the design idea of integrating the functions of urban government in the construction of ecological civilized city, that is, the functions of economy, culture, society and environment (as shown in **Figure 1**).

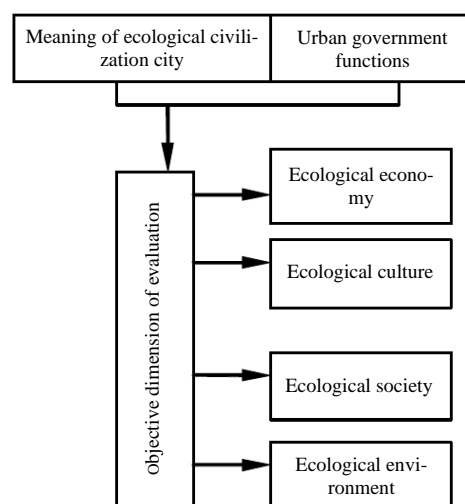


Figure 1. Evaluation index system model of ecological civilized city.

4.1. Eco economic evaluation index design

The development of urban ecological civilization must rely on the development of ecological economy as the material guarantee Professor Zhang, a famous scholar of philosophy of science and technology in China, believes that ecological economy refers to an economy that makes sustainable creation and fair and reasonable distribution of spiritual and material wealth ethically, rationally and ecologically for the common interests of the whole mankind and our planet^[11]. Wang believes that ecological economy is organized based on the

principle of system ecology and the law of market economy. It is a network and evolutionary compound ecological economy with efficient resource metabolism process, complete system coupling structure and overall, collaborative, circular and self generating functions^[12].

It can be seen that urban ecological economy, as a scientific outlook on development and a new economic development model, has the following characteristics. First, timeliness, which refers to the sustainability of resource utilization in the time dimension. The second is spatiality, which refers to the sustainability of resource utilization in the spatial dimension. The third is efficiency, which refers to the efficiency of resource utilization in the efficiency dimension, that is, low consumption and efficient resource utilization. Therefore, the eco-economic evaluation indicators include resource metabolism level, energy consumption level, sewage treatment level and green economic development level.

The level of resource metabolism represents the sustainable utilization level of urban resources, which includes both land surface resources and underground resources. It includes both renewable and non renewable resources. The high level of resource metabolism indicates that the city's economic development is in a benign operation and has strong sustainability. Therefore, the evaluation of resource metabolism level includes per capita tree planting area, per capita greening area, per capita water supply, per capita total energy production, per capita total mineral production and per capita total renewable resources production.

Energy consumption level represents an important indicator of building an energy-saving city. global energy shortage has become a core issue in the development of cities in the 21st century. In addition to using scientific and technological innovation to vigorously develop new and renewable energy, reducing unit energy and improving energy efficiency are important means. Therefore, the evaluation of energy consumption level includes:

per capita primary energy consumption, RMB 10,000 GDP primary energy consumption, per capita energy consumption of the government, per capita energy consumption of public institutions and per capita renewable energy consumption.

The pollution control level represents the degree of efforts for the development of ecological economy. At present, economic development inevitably produces pollutants. The use of science and technology to control pollutants is an inevitable move for the development of ecological economy. Therefore, the evaluation indicators of pollution control level mainly include: the discharge of industrial waste gas per capita, the discharge of waste water per capita, the comprehensive utilization rate of industrial solid waste and the discharge standard rate of industrial three wastes.

Green economy is a new economic form developed for the purpose of harmony between economy and environment. It is a sustainable development state of industrial economy to meet the needs of human environmental protection and health. Green economy evaluation indicators mainly include per capita green GDP and growth rate, per capita GEP and growth rate, the proportion and rise and fall rate of output value of high-tech industries in industries above designated size, the number and rise and fall range of patent applications, the proportion and rise and fall range of added value of tertiary industry in green GDP, the total import and export volume and growth rate among them, per capita green GDP refers to the per capita accounting index of the real national wealth newly created by the city after deducting the loss of natural assets. In short, it is to deduct the cost of environmental resources and the cost of environmental resources protection services from the current statistical GDP, so as to obtain the real total national wealth GEP per capita, i.e. gross ecosystem production per capita, measures and displays the development of urban ecological economy by calculating the gross production per capita of forest, desert, wetland, farmland, pasture, aquaculture and other artificial ecosystems.

4.2. Design of ecological culture evaluation index

Culture is not only the guiding role of urban development, but also the role of regulating and controlling the city, but also the role of cohesion in urban development. Ecological culture is a culture from the rule of man over nature to the harmonious development of man and nature. The key to this transition is the transformation of values. Yu believes that the development of ecological culture includes major changes in three main levels of culture, namely, institutional level, material level and spiritual level. It is faced with a series of fundamental choices of social system, social consciousness and human spirit^[13]. To this end, urban ecological culture is to vigorously publicize and carry out activities to awaken the public's awareness of ecological protection, reflect the urban characteristics, the ecotourism culture, ecological livable culture, ecological folk culture and ecological catering culture preached among the citizens. Ecological culture advocates less pollution, less damage and non violence, and has the awareness and behavior of saving resources. It is a concrete manifestation of material civilization and spiritual civilization. It is the source of ecological civilization city construction.

The evaluation of urban ecological culture is mainly aimed at the ecological consciousness of urban residents and reflects the level of urban material ecological culture and spiritual ecology.

Ecological consciousness refers to the consciousness of citizens to participate in environmental protection based on their basic values under the condition of understanding the environment. It is finally reflected in the behavior conducive to environmental protection. Ecological consciousness is the soul of urban ecological culture. The evaluation indicators of ecological awareness include: the change of urban residents' understanding of nature, the implementation of citizens' ecological ideology, ecological cultural concept and ecological behavior rules.

Material ecological culture is the core of ecological culture, the material carrier of culture and the foundation of spiritual ecological culture. It guides and dominates other elements of ecological culture. It not only affects the behavior of ecological subjects, but also affects the effectiveness of ecological activities. The evaluation indicators of urban material ecological culture mainly include: the influence of urban ecotourism culture, ecological livable culture, ecological folk culture, ecological catering culture, etc.

Spiritual ecological culture mainly refers to the healthy and positive spiritual life of urban residents, which is specifically reflected in the utilization of urban residents' spare time. Therefore, the evaluation indicators of spiritual ecological level mainly include: per capita reading time per month, per capita physical exercise time per month, per capita TV watching time per month, and per capita travel time per month.

4.3. Design of evaluation indexes of eco society

The development of urban ecological civilization must strive to improve the level of urban social development and provide security for the development of ecological civilization cities. American scholar Roy Morrison believes that ecological society is to understand nature from the perspective of ecology^[14]. German scholar Hermanscher believes that ecological society should be guided by system theory and based on the integration of economics, ecology and sociology. It aims to change the production and consumption mode, culture and institutional concept of industrial society, make efficient and rational use of all renewable resources, and change from a carbon based economy to a hydrogen based economy^[15]. Chinese scholar Yao believes that ecological society is not only a society with a virtuous circle between man and nature, but also a society with sociality, emphasizing the stability, fairness, harmony and sustainable development of human society^[16]. Professor Bai pointed out from the perspective of ecological philosophy that eco-

logical society refers to the harmony and ecology of human social relations^[17].

To sum up, urban ecological society refers to the direct and indirect intervention of the urban government in the urban field, and the urban government directly and indirectly provides relevant social services to the public. The fundamental purpose of ecological society is to improve the quality of life, maintain social order and promote social harmony.

The level of education reflects the degree to which the city government attaches importance to education development and makes efforts to improve it. It also shows the level of urban human resources development and talent reserve, which is the intellectual support for social development. The evaluation indicators of education level include the number of 10,000 students, the proportion of non-agricultural population in the total population, the number and level of colleges and universities, and the number of 10,000 college students.

The level of health reflects the importance of the city government to sports and the degree of efforts to improve it. It also shows the understanding and behavior of urban residents on physical and mental health, which is the physical support for social development. The evaluation indicators of health level include hospital beds for 1,000 people, sports venues for 10,000 people, annual medical expenses per capita and life expectancy per capita.

Employment is the main source of urban residents' material and spiritual life, the main factor of urban social stability, and the concrete embodiment of the urban government's concern for people's livelihood and understanding of people's conditions. The evaluation indicators of employment include: urban registered unemployment rate and recognition of safe and comfortable environment.

The higher per capita living standard, especially the large number of middle-income people, is conducive to building a harmonious city and ecological city the evaluation indicators of per capita

living standard.

Harmonious social relationship is the main symbol of a beautiful living city. They not only have material and spiritual enjoyment, but also need good interpersonal relationships to share happiness and sorrow the evaluation indicators of harmonious social relations include neighborhood relations, colleague relations, family relations and urban atmosphere.

The social security system is the main way for the urban government to distribute and redistribute the national income and guarantee the basic living rights of urban residents, especially those with special difficulties. The essence of social security is to maintain social equity and promote social stability and development. Social security consists of social insurance, social relief, social welfare, preferential care and resettlement, etc. The social security evaluation price index system includes: social security coverage rate and per capita social security funds.

Social order is the rules of conduct, moral norms, laws and regulations that people must abide by in urban activities. Good social order shows that urban residents can maintain balance in a dynamic and orderly social state. The evaluation indicators of social order include: the number of contradiction mediation institutions with 10,000 people, the persuasion level of contradiction mediators, the visibility of outdoor police, the per capita Road area, and the number of traffic violations with 10,000 people.

4.4. Design of ecological environment evaluation index

Environmental capacity is extremely important for the development of urban ecological civilization. The development of urban economy, culture and society must adapt to the environmental capacity in order to ensure the sustainable development of the city. Urban ecological environment is an artificial environment suitable for human survival and development after processing and transformation on the basis of natural environment. Urban ecological

environment is a huge system. In a broad sense, it includes human centered natural environment, socio-economic environment with a complex hierarchical structure. Due to its complexity, multidimensional and people's cognitive limitations, the concept, theory and technical system of urban ecological environment index system are not very mature, and many problems are still in the exploratory stage^[18]. At present, Chinese scholars mostly study from the broad urban ecological environment evaluation. For example, Wang Ping determined that the ecological environment index system of Nanjing includes natural environment and socio-economic environment^[19]. Fu believes that the evaluation of urban ecological environment should include ecological analysis and economic analysis of urban ecosystem. At the same time, the change of driving factors in the ecological process, the causal relationship of ecological change and the expansion of spatial scale will all cause the lag effect of ecological process^[20]. This paper refers to the evaluation of ecological environment in a narrow sense, that is, the evaluation of urban object space ecological environment, natural ecological environment and coordination and comfort.

The object space ecological environment represents the city's cultural characteristics, historical imprint, the coordination between the civilization of modern elements and the natural environment, and intuitively expresses the external embodiment of the construction of urban ecological civilization. Therefore, the evaluation indicators of the ecological environment of the object space include comfortable and beautiful building design, proper and coordinated placement of public facilities, greening coverage rate and scientific greening space design.

Natural ecological environment is a whole system composed of various natural factors surrounding people with certain ecological relations, and it is the material basis for human survival. Human beings are the product of nature, and human activities affect the natural environment. In today's "people-oriented" and advocating nature, a comfortable natural ecological environment has become

an important part of building an ecological civilized city. Therefore, the natural ecological environment assessment indicators include: annual excellent rate of air quality, annual average temperature, annual precipitation, water quality standard rate, noise pollution degree, soil erosion rate, geographical vulnerability index and the proportion of unused land.

According to the evaluation index system model of ecological civilized city, exploring the evaluation index elements has a certain theoretical basis, but it lacks a practical basis. Therefore, it is necessary to further select them by using social science research methods combined with the importance and feasibility of actual evaluation.

5. Select the evaluation index system of ecological civilized city

According to the Delphi method, 40 urban government management experts, ecological civilization research experts and ecological civilization city evaluation experts are scored and counted respectively. The importance of the index to the evaluation of ecological civilization city is judged according to the average score. The greater the average score, the more important the index is, that is, the more effective it is to evaluate ecological civilization city. In the expert questionnaire, the importance of indicators is evaluated by Likert five level scale method, which is divided into five levels: "very important", "important", "general", "less important" and "unimportant". Each level is assigned 5, 4, 3, 2 and 1 respectively, and the average value is taken. Generally speaking, when the average score is lower than 2, it means that the index is not important for the evaluation of ecological civilized cities, and it will be eliminated; when the average score is higher than 2, it means that the index is more important for the evaluation of ecological civilization city, and it will be retained. Accordingly, the design of eco-economic evaluation index, eco-cultural evaluation index, eco-social evaluation index and eco-environmental evaluation index are statistically analyzed in turn, and the indexes are

selected according to the principle of average score, eliminating unimportant indexes and supplementing missing indexes.

The selection of ecological and economic

evaluation index system is taken as an example for specific description. According to the design of ecological and economic evaluation indexes, 21 evaluation indexes are obtained, as shown in **Table 1**.

Table 1. Eco economic evaluation index system

Target dimension	Criterion dimension	Serial number	Evaluation index system	Average value
Ecological economy	Resource metabolism level	1	Per capita tree planting area	4.75
		2	Per capita green area	3.33
		3	Per capita water supply	2.75
		4	Total energy production per capita	3.67
		5	Per capita mineral production	3.92
		6	Per capita renewable resource production	4.92
	Energy consumption level	7	Per capita primary energy consumption	2.99
		8	10,000 yuan GDP primary energy consumption	4.75
		9	Government per capita energy consumption	1.89
		10	Per capita energy consumption of public institutions	1.92
		11	Per capita consumption of renewable energy	4.75
	Pollution control level	12	Per capita emission of industrial waste gas after treatment	3.88
		13	Per capita wastewater discharge after treatment	4.00
		14	Comprehensive utilization rate of industrial solid waste	4.91
		15	Standard rate of industrial three wastes discharge	4.88
	Development level of green economy	16	Per capita green GDP and growth rate	4.20
		17	Per capita GEP and growth rate	4.98
		18	Proportion and rise and fall rate of output value of high-tech industries in industries above designated size	4.11
		19	Proportion of added value of tertiary industry in green GDP and its fluctuation range	3.88
		20	Number of patent applications and rise and fall range	3.57
		21	Total import and export and growth rate	1.55

Table 2. Practical index system of eco economic evaluation

Target dimension	Criterion dimension	Serial number	Evaluation index system	Average value
Ecological economy	Resource metabolism level	1	Per capita tree planting area	4.75
		2	Per capita green area	3.33
		3	Per capita water supply	2.75
		4	Total energy production per capita	3.67
		5	Per capita mineral production	3.92
		6	Per capita renewable resource production	4.92
	Energy consumption level	7	Per capita primary energy consumption	2.99
		8	10,000 yuan GDP primary energy consumption	4.75
		9	Per capita consumption of renewable energy	4.75
		10	Per capita emission of industrial waste gas after treatment	3.88
	Pollution control level	11	Per capita wastewater discharge after treatment	4.00
		12	Comprehensive utilization rate of industrial solid waste	4.91
		13	Standard rate of industrial three wastes discharge	4.88
		14	Per capita green GDP and growth rate	4.20
	Development level of green economy	15	Per capita GEP and growth rate	4.98
		16	Proportion and rise and fall rate of output value of high-tech industries in industries above Designated Size	4.11

Table 3. Practical index system of ecological culture evaluation

Target dimension	Criterion dimension	Serial number	Evaluation index system	Average value
Ecological culture	Residents' ecological consciousness	1	Changes in residents' understanding of the relationship between nature	4.45
		2	Citizens' ecological ideology	3.15
		3	Concept of ecological culture	3.07
		4	Implementation of ecological behavior rules	4.87
	Material ecological culture	5	Influence of ecotourism culture	4.19
		6	Influence of ecological livable culture	3.75
		7	Influence of ecological folk culture	4.84
		8	Influence of ecological diet culture	2.92
	Spiritual ecological level	9	Reading time per month	4.81
		10	TV news time per month	2.49
		11	Monthly physical exercise time	4.79
		12	Travel time per month	4.01

Table 4. Practical index system of eco social evaluation

Target dimension	Criterion dimension	Serial number	Evaluation index system	Average value
Ecological Society	Educational level	1	High school education rate	4.75
		2	Proportion of non-agricultural population in the total population	3.33
		3	10,000 college students	4.15
	Level of health	4	10,000 people playground	3.21
		5	Per capita annual medical expenses	4.85
		6	Life expectancy	4.79
	Obtain employment	7	The registered urban unemployment rate	4.87
		8	Recognition of safe and comfortable environment	4.00
	Per capita living standard	9	Engel coefficient	4.74
		10	Per capita wage	4.11
		11	Per capita living area	3.98
		12	Urban population density	2.11
		13	Urban gas utilization rate	3.48
	Harmonious social relations	14	Neighborhood relations	4.34
		15	Colleague relationship	4.98
		16	Family relations	4.71
		17	Urban atmosphere	3.88
	Social security system	18	Social security coverage	4.35
		19	Per capita social security funds	4.77
	Social order	20	Persuasion level of conflict mediators	4.21
		21	Outdoor police visibility	3.89
		22	Per capita Road area	2.77
		23	Number of traffic violations per 10,000 people	3.97

According to the expert survey results, the selected 21 indicators are basically important for the evaluation of urban ecological economy. From the average score, the average score of the three indicators of per capita energy consumption of the government, per capita energy consumption of public institutions, total import and export volume and growth rate is less than 2. Excluding this indicator and retaining other indicators, 18 practical indica-

tors for the final ecological economy evaluation are obtained, as shown in **Table 2**.

Using the same method, we can get the practical index system of ecological culture evaluation, the practical index system of ecological society evaluation and the practical index system of ecological environment evaluation. See **Table 3** for the practical index system of ecological culture evalua-

tion; see **Table 4** for the practical index system of eco social evaluation; see **Table 5** for the practical

index system of ecological environment assessment.

Table 5. Practical index system of ecological environment assessment

Target dimension	Criterion dimension	Serial number	Evaluation index system	Average value
Ecological economy	Object space ecological environment	1	The building design is comfortable and beautiful	4.75
		2	Proper and coordinated arrangement of public facilities	3.93
		3	Greening coverage	3.75
		4	Green space design science	3.67
	Natural ecological environment	5	Annual excellent rate of air quality	4.89
		6	Annual average temperature	4.75
		7	Annual precipitation	3.89
		8	Water quality compliance rate	3.90
		9	Soil erosion rate	3.12
		10	Geographic vulnerability index	4.16
		11	Proportion of unused land	3.55

6. Conclusions

The evaluation of ecological civilization city is a systematic project involving many disciplines. The research on the construction of ecological civilization city evaluation index system in China is still in the primary stage. This paper mainly studies the evaluation index system of ecological civilization city from the perspective of urban government functions, which involves a more comprehensive content, which not only reflects the efforts of urban government in the construction of ecological civilization, but also reflects the current situation and characteristics of urban ecological civilization. Through the evaluation, this paper explores the deficiencies in the construction of urban government ecological civilization, and puts forward targeted countermeasures and suggestions to strengthen the construction of ecological civilization city.

Conflict of interest

The authors declare no conflict of interest.

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