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Research on Evaluation Index System of Ecological Construction in Shandong Province

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ABSTRACT. *Based on the theoretical basis of ecological civilization construction related research both at home and abroad, starting from the actual situation of Shandong province, this paper establishes objective and scientific evaluation index system of ecological construction in Shandong province, and evaluates ecological civilization construction in Shandong and 17cities, hoping to promote the progress of ecological civilization construction in Shandong province.*

KEYWORDS: *Ecological Shandong province, the evaluation index system, Ecological civilization*

1. Introduction

The construction of ecological civilization is an important part of the cause of socialism with Chinese characteristics. It is related to the well-being of the people and the future of the nation. It is also related to the goal of "two one hundred" and the realization of the Chinese nation's great renaissance of the Chinese dream. The CPC Central Committee and the State Council attach great importance to the construction of ecological civilization. It has introduced a series of major decisions and plans to promote the construction of ecological civilization, and has made significant progress and positive results. However, on the whole, the level of ecological civilization construction in China still lags behind economic and social development, resource constraints tend to be tense, environmental pollution is serious, ecosystems are degraded, and the contradiction between development and population resources and environment is increasingly sharp. These issues have become a major bottleneck restricting economic and social sustainable development.

Shandong is a major economic province along the eastern coast of China. Since the reform and opening up, the economy has developed rapidly and its comprehensive strength has been significantly enhanced. However, the contradiction between supply and demand of natural resources such as water resources is sharp,

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and the total emission of major pollutants such as chemical oxygen demand and sulfur dioxide ranks the top of the country. The ecological environment system is fragile, and the extensive economic growth mode still dominates. In addition, there are problems such as the lag of urban environmental infrastructure and the large population base. Therefore, on September 26, 2003, the Fourth Session of the Standing Committee of the Tenth National People's Congress of Shandong Province adopted the *Resolution on Building an Ecological Province*. On January 17, 2012, the Shandong Provincial People's Government of Shandong Province made a decision on the construction of ecological Shandong. The government's goal is to achieve an ecological and economic development pattern that is compatible with economic and social development and resource and environmental carrying capacity by 2020. The capacity for sustainable development is significantly enhanced, the urban and rural environmental quality is comprehensively improved, and the natural ecosystem is effectively protected. The concept of civilization is more solid, and the people's wealth and civilization are obviously improved. To be the first to establish a model province for recuperating rivers and lakes, and strive to embark on a civilized development path of production development, affluent life and good ecology.

2. Construction of Ecological Shandong Construction Evaluation System

2.1 Construction principles of the evaluation index system

Because ecological Shandong construction has its own special regional and cultural characteristics, it is different from other parts of the country. And the original intention and direction indicator system are designed to better serve the practice. Therefore, in the study of the general problem and the construction of this indicator system, the basic principles of the design work should include the following aspects:

Scientific: When designing the ecological Shandong construction evaluation index system, the indicators should be accurately selected, and the scientific method should be used to design the system to determine the weight of each indicator. And at the same time, scientific methods can be used to establish an evaluation model and to calculate the evaluation index.

Integrity: Ecological civilization is a scientific theory involving many fields such as nature, resources, economy, culture, society, science and technology, and environment, which is a complete system. It should reflect the dynamic changes and development trends of ecological civilization construction from multiple angles, and it must have indicators of the main characteristics and status of various systems such as economic development, living environment and social and cultural level.

Purpose: The design of ecological Shandong evaluation system is to be able to evaluate the comprehensive and complex conclusions of the index system, as well as reflect its own pursuit of the initial establishment of the goal of civilization. In this process, the purpose of regression evaluation should be discussed at a hierarchical level.

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Dynamic: The construction of ecological civilization is not a goal, but a development process, which is constantly changing. Therefore, the index data comes from different time and different regions, so that the present situation and dynamic changes of ecological Shandong construction can be observed.

Maneuverability: In the selection of indicators, we should fully consider the measurability, authenticity, difficulty and accessibility of statistical data, so that the index data can be collected, compared, and easy to quantify processing.

Comparability: The index system of research and design can not only compare vertically between the level of ecological Shandong construction and that of ecological civilization in different time periods, but also compare horizontally between different cities at the same time, so as to analyze the effect of ecological civilization construction in Shandong province and the gap between 17 cities and to put forward reasonable improvement measures and countermeasures.

2.2 Thoughts on Evaluation Index system

The evaluation index system of ecological Shandong construction is designed to evaluate and present the standard with the characteristics of ecological civilization construction in Shandong province. Constructing the evaluation index system can effectively detect which factors have an impact on the harmonious development of economic development, ecological environment and social and cultural atmosphere, and can realize the goal of people-oriented, good ecological environment, economic development and social civilization. Ecological Shandong Construction is a process of coordination and scientific development of three subsystems of" ecological economy-ecological environment-ecological culture". Therefore, the establishment of ecological Shandong Index System is also from these three aspects mentioned above.

2.3 Establishment of Evaluation index system

Generally speaking, the construction of the evaluation system of ecological civilization construction should take full account of the indicators that can represent the construction of ecological civilization. The construction of the evaluation Index system of ecological Shandong Construction, which is written in this thesis, emphatically refers to the Evaluation index of ecological civilization construction in China province, *Outline of Shandong Ecological Province construction plan*, Comprehensive evaluation system of ecological City, *Ecological county, ecological city, Ecological province Construction Index*, etc. The key points and elements have divided the evaluation indexes of ecological Shandong construction into three subsystems such as ecological economy, ecological environment and ecological culture. 25 indexes are selected, which are shown in table 1-4.

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2.4 Determination of the weight of each evaluation indicator

In this thesis, the Analytic Hierarchy Process and Delphi method are selected to determine the weight of each evaluation index, and the results are shown in table 1.

Table 1 Index weight of ecological Shandong Construction evaluation System

System Level	Weight	Index Level	Unit	Weight in the target level	Weight In the system level	Property
Ecological economyB1	0.5396	GDP per capita C11	Yuan	0.0588	0.109	Positive indicators
		General public budget revenue C12	One hundred million yuan	0.0435	0.0806	Positive indicators
		The per capita net income of farmersC13	Yuan	0.0306	0.0566	Positive indicators
		Per capita disposable income of urban residentsC14	Yuan	0.0372	0.069	Positive indicators
		Output value of high-tech industry C15	One hundred million yuan	0.0403	0.0746	Positive indicators
		Tertiary industry accounts for the proportion of GDP C16	%	0.0871	0.1615	Positive indicators
		Energy consumption per ten thousand yuan of GDP[1] C17*	%	0.0735	0.1363	Inverse indicator
		Power consumption of 10 thousand yuan GDP of the province ① C18	%	0.0963	0.1785	Inverse indicator
		The proportion of investment in environmental pollution control in GDP C19*	%	0.0723	0.1339	Positive indicators
Ecological environment B2	0.297	Forest coverage C21	%	0.0752	0.2533	Positive indicators
		City proper greening coverage C22*	%	0.047	0.1582	Positive indicators
		Comprehensive control of soil erosion area C23	Square kilometers	0.0136	0.0458	Positive indicators
		Mine environmental restoration area C24	ha	0.0145	0.0488	Positive indicators
		Total sulfur dioxide emission C25	Ten thousand tons of	0.0299	0.1007	Inverse indicator
		Comprehensive	Ten thousand	0.0329	0.1108	Positive

[1] percentage rise or fall over the previous year

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		utilization of industrial solid waste C26*	tons of			indicators
		Harmless disposal of household garbage C27*	Ten thousand tons of	0.0359	0.1209	Positive indicators
		Annual urban sewage treatment capacity C28*	Ten thousand tons of	0.0296	0.0997	Positive indicators
		Agricultural fertilizer seems (converting) C29*	Ten thousand tons of	0.0183	0.0616	Inverse indicator
Ecological cultureB3	0.1634	Natural population growth rate C31	‰	0.0267	0.1636	Inverse indicator
		Urbanization rate C32	%	0.0473	0.2895	Positive indicators
		Area of nature reserve C33	Million per hectare	0.0276	0.1687	Positive indicators
		All residents' expenditure on education, culture and entertainment C34	Yuan per person	0.0171	0.1046	Positive indicators
		Enrollment in colleges and universities C35	Person	0.0182	0.1115	Positive indicators
		Number of cultural institutions C36	Institution	0.0114	0.0701	Positive indicators
		Per capita park green area C37	Square meter	0.0151	0.0921	Positive indicators

*Note: with * number for the <<Outline of Shandong Ecological Province construction plan>>, planning Index table* combined *with the actual increase in Shandong province indicators.*

As can be seen from the above table, ecological Shandong construction is affected by per capita GDP, general public budget income, output value of high-tech industry, proportion of tertiary industry in regional GDP, energy consumption per ten thousand yuan of GDP, electricity consumption per ten thousand yuan of GDP, proportion of environmental pollution control investment in GDP, forest coverage rate, green coverage rate and urbanization rate of urban built-up areas, among which, the most influential indicators are power consumption per ten thousand yuan of GDP, proportion of tertiary industry in regional GDP, forest coverage rate, energy consumption per ten thousand yuan of GDP, proportion of environmental pollution control investment in GDP. Therefore, in order to ensure the smooth construction of ecological Shandong, it is necessary to first save energy and reduce consumption, second to improve the tertiary industry and high-tech industry level, increase fiscal revenue, increase investment in the field of environmental pollution control, and finally to increase the green coverage area.

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3. An empirical analysis of ecological Shandong Construction evaluation

3.1 Collection of indicator data

The index data are derived from the 2011-2018 Shandong Statistical Yearbook, the 2011-2017 China Environment Statistics Yearbook, the 2010-2018 Shandong Province National Economic and Social Development Statistics Bulletin, Shandong Province Education Development Statistics Bulletin, 2011-2018 Shandong City National Economic and Social Development Statistics bulletin, Shandong City Environmental Quality report and national Ecological Civilization construction demonstration County, municipal indicators (trial) as well as the National Bureau of Statistics, Shandong Statistical Information Network, Shandong Province Environmental Protection Department website.

Table 2 Index data of ecological Shandong construction from 2010 to 2017

	2010	2011	2012	2013	2014	2015	2016	2017	Unit
GDP per capita C11	41106	47335	51768	56885	60879	64168	67706	72807	Yuan
General public budget revenue C12	2749.38	3455.93	4059.43	4559.95	5026.83	5529.33	5860.18	6098.63	One hundred million yuan
The per capita net income of farmers C13	6990	8342	9446	10620	11809	12849	13954	15118	Yuan
Per capita disposable income of urban residents C14	19946	22792	25755	26882	29222	31545	34012	36789	Yuan
Output value of high-tech industry C15	31602	28125	33661	39583	44566	47719	51401	52133	One hundred million yuan
Tertiary industry accounts for the proportion of GDP C16	36.6	38.3	40.0	42.0	43.5	45.3	47.3	48	%
Energy consumption per ten thousand yuan of GDP C17	-4.39	-3.77	-4.55	-4.48	-5	-3.72	-5.15	-6.94	%
Power consumption of 10 thousand yuan GDP of the province C18	-0.3	-0.58	-4.89	-1.78	-4.84	-6.49	-2.09	-6.17	%
The proportion of investment in environmental pollution control	1.5	1.35	1.59	1.55	1.39	1.1	1.15	1.15	%

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in GDP C19									
Forest coverage C21	16.72	16.72	16.72	16.73	16.73	16.73	16.73	16.73	%
Green coverage in urban built-up areas C22	38.6	39.2	39.6	39.7	40.2	40.12	42.3	42.1	%
We will comprehensively bring soil erosion under control C23	1600	1600	1662	1600	1600	1793	1262	1320	Square kilometers
Mine environmental restoration area C24	3278	3817	2235	4069	2120	4001	1349	1349 **错误!未定义书签。**	ha
Total sulfur dioxide emission C25	188.1	182.7	174.9	164.5	159	152.6	113.5	74	Ten thousand tons of
Comprehensive utilization of industrial solid waste C26	15297	18298	17043	17134	18380	18308	18976	19026	Ten thousand tons of
Harmless disposal of household garbage C27	911.63	887.85	1041.7	1002	958.5	1377.5	1466.2	1591.3	Ten thousand tons of
Annual urban sewage treatment capacity C28	222691	247328	261415	266889	280596	289339	307953	317772	Ten thousand tons of
Agricultural fertilizer seems (converting) C29	1439.48	1427.09	1423.5	1412.93	1407.1	1395.22	1374.54	1332.28	Ten thousand tons of
Natural population growth rate C31	5.39	5.4	4.95	5.01	7.39	5.88	10.84	10.14	‰
Urbanization rateC32	48.3	50.9	52.43	53.75	55.01	57.01	59.02	60.58	%
Area of nature reserve C33	113.5	109.8	108.2	110	111.9	111.9	111.9	113.6	hectares
All residents' expenditure on education, culture and entertainment C34	1401.8	1538.4	1655.9	1136.6	1303	1557.3	1754.6	1948.4	Yuan per person
Enrollment in colleges and universities C35	475215	480753	466695	491557	533622	540809	555211	548479	Person
Number of cultural institutions C36	20162	20162	18484	17023	15363	16955	15131	14575	Institution
Per capita park green area C37	15.84	16	16.4	16.8	17.1	17.4	17.9	17.8	Square meters

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3.2 Dimensionless treatment of index data

The methods of data dimensionless processing mainly have minimum-maximum standardization, Z-score standardization and standardization according to decimal calibration. In this thesis, the minimum-maximum standardization method is used to process the index data dimensionless. Formulas can be expressed as:

$$x_{ij} = \frac{a_{ij} - \min a_{ij}}{\max a_{ij} - \min a_{ij}}, a_{ij} \text{ for forward indicators}$$

$$x_{ij} = \frac{\max a_{ij} - a_{ij}}{\max a_{ij} - \min a_{ij}}, a_{ij} \text{ for backward indicators}$$

In the formula: a_{ij} -the original data of the indicator, x_{ij} -the data after the indicator is standardized.

3.3 Empirical analysis of ecological Shandong construction evaluation

Collection of indicator data:

The weighted sum method is adopted to obtain the ecological Shandong comprehensive development index. The model formula of single factor evaluation is:

Calculate the score of each factor:

$F_{ij} = \sum x_{ij} * w_{ij}$ (i=1, 2 ..., 6; j=1, 2... n) In the formula, x_{ij} Is the evaluation value of the JTH index of the ith system layer; w_{ij} Is the weight of the JTH index of the ith system layer; N is the number of evaluation indexes.

The weighted sum of ecological Shandong comprehensive development index SD is expressed as: $SD = \sum F_{ij}$ (i=1, 2, 3; j=1, 2....n). In the formula, SD is ecological Shandong comprehensive development index. The calculation formula of sub-index development index of each system layer is $I_i = F / w_i = \sum F_{ij}\, w_{ij} / w_i$, (i=1, 2, 3; j=1, 2,...n). In the formula, w_i Is the weight of sub-index of the ith system layer.

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4. Ecological construction in Shandong index calculation results and analysis

4.1 The overall analysis

Table 3 Comprehensive development index of ecological Shandong construction from 2010 to 2017

Year	2010	2011	2012	2013	2014	2015	2016	2017
Index	0.17	0.22	0.39	0.48	0.59	0.65	0.68	0.86

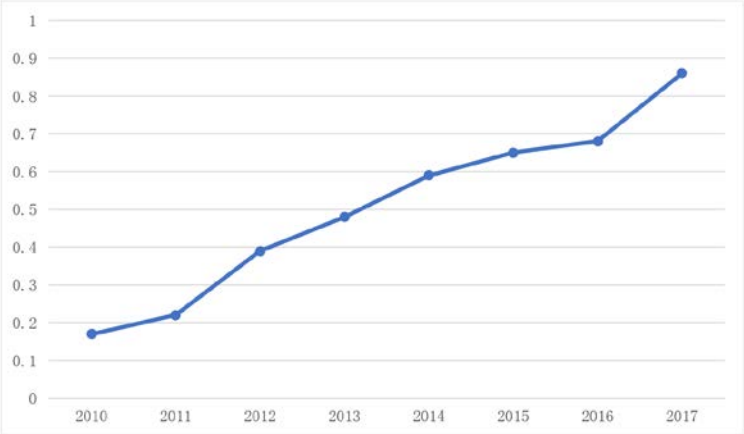

Figure. 1 Change chart of comprehensive development index of ecological Shandong construction from 2010 to 2017

According to the evaluation results (table 3), the ecological Shandong construction index from 2010 to 2017 was 0.17, 0.22, 0.39, 0.48, 0.59, 0.65, 0.68, and 0.86, respectively, showing an increasing trend year by year, indicating that the ecological civilization of Shandong province has been continuously strengthened since the beginning of ecological Shandong construction (as shown in figure 3-1).

According to the overall development of the ecological construction in Shandong index changes, it is visible in 2012 before the decision of the people's government on the construction of ecological Shandong, Shandong ecological province construction has accomplished achievements, which was in the stage of rapid development. From 2012 to 2016 the slower growth rate mainly due to the indicators of the ecological economic system slower growth, the ecological environment system even the lower part of the indicators, such as comprehensive control of soil erosion area changed little between 2010 to 2014, after rising to 1793 square kilometers in 2015, 2016 and 2017 respectively, down to 1262 and 1320 square kilometers; Industrial solid waste comprehensive utilization in 2012 and 2013 Numbers less than 2011, 2014 back to 2011 levels; Living garbage harmless

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treatment from 2012 to 2014 is on the decline. For example, the natural growth rate of population in 2012 and 2013 was relatively low, which was 4.95‰ and 5.01‰ respectively, lower than that in 2010 and 2011. All the residents' education and cultural entertainment consumer spending in 2012 to 2014 showed a trend of decline, even lower than in 2010 and 2011, consumption; Number from cultural institutions after 2011 has been a declining trend. Compared with 2015, the index rose by only 0.03 in the six years, mainly due to the significantly lower indicators such as soil erosion area under comprehensive control, ecological environment restoration area of mines and total so2 emission. In 2017, the index rose significantly, mainly due to the province's ten thousand-yuan GDP electricity consumption decreased significantly, all residents' education, culture and entertainment consumption expenditure increased significantly, and all indicators of the ecological economic system showed an upward trend.

4.2 Three systems analysis

In order to further illustrate the change of the ecological province construction since 2010 in Shandong province, the analysis on three subsystems such as ecological economy, ecological environment and ecological culture is as follows.

Table 4 Indexes of three sub-systems of ecological Shandong construction from 2010 to 2017

	2010	2011	2012	2013	2014	2015	2016	2017
Ecological economy	0.15	0.16	0.48	0.46	0.61	0.60	0.62	0.87
Ecological environment	0.07	0.23	0.23	0.53	0.57	0.71	0.81	0.90
Ecological culture	0.43	0.41	0.40	0.45	0.54	0.71	0.66	0.77

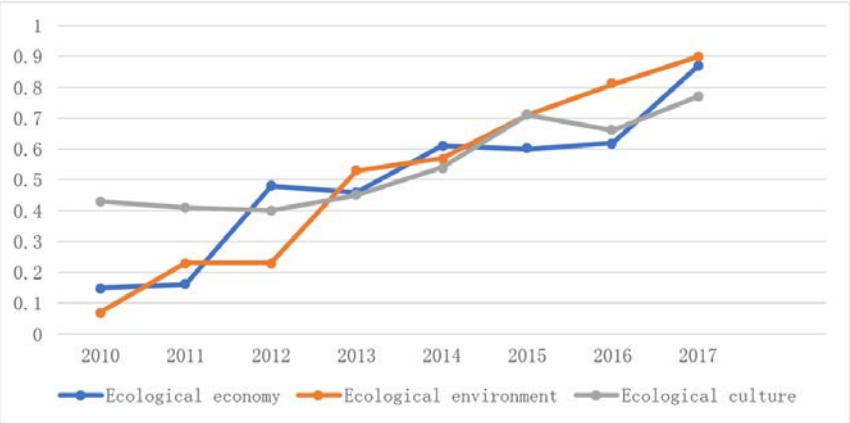

Figure. 2 Index changes of three subsystems of Shandong ecological construction from 2010 to 2017

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As can be seen from the table 4, the ecological construction in Shandong three subsystems of ecological economy, ecological environment and ecological culture, on the whole, shows a rising trend: in 2010, the ecological culture ranks the highest and the second is ecological economy, and the last is the ecological environment. After 2017, the score of ecological and cultural system decreased, and the highest score was for ecological environment, followed by ecological economy. The obvious change is the ecological environment curve, which shows that the ecological environment system indicators grow rapidly. For now, the three subsystems have made significant progress, but the development of the three is unbalanced.

From the point of ecological economic system change trend of curve, 2012 index increased sharply, mainly due to urban per capita disposable income increased, ten thousand yuan GDP and significantly reduce the power consumption. In 2013, the proportion of this index decreased less than that of last year, resulting in a 0.2 drop in the eco-economic system index in 2013.

From the point of the change trend of ecological environment system curve, 2012 and 2013 index was flat, the main reason is that two indicators mine environmental recovery area and industrial solid waste comprehensive utilization showed a trend of decline, mine environmental recovery area growth of about 1.8 times in 2013, is the main reason for the index rose in the system.

From the point of curve change trend of the ecological culture system, the cause of the decline in 2010-2012 is a nature reserve area and the decline of cultural institutions for two indicators. The natural population growth rate increase is led to the decrease of the system index in 2016.

5. Conclusion

As can be seen from the empirical analysis and evaluation results of Shandong province and 17 prefectures, the level of ecological civilization construction in Shandong province has been continuously improved from 2010 to 2017. Before the decision of Shandong provincial party committee and Shandong provincial people's government on the construction of ecological Shandong in 2012, the construction of Shandong ecological province had made some achievements. Since 2012, it can be found that the construction index of Shandong ecological province presents a good situation and steadily rises. However, the construction of ecological civilization is the foundation of realizing the sustainable development of the Chinese nation and long-term planning for ecological construction will not stop in Shandong in 2020. Further implementation of the scientific concept of development, will be the theme of scientific development to infiltration and fast transformation of the mode of economic development and make it become the economic and social development of the main line. Also keep in mind the people-oriented which is the principle of ecological priority, and learn to plan and coordinate the development of the economic society and resources environment. It is necessary to formulate and implement strict scientific resources and environment management system, from the

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results on the forced change the way of economic development, from the protection on the result of human ecological environment, energy conservation and emission reduction in order to optimize the economic structure. We will strengthen the system building at the economic, environmental and cultural levels and strive to build an ecological Shandong with prosperous economy, prosperous people, beautiful environment and harmonious society.

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