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Construction of Evaluation System of Provincial Ecological Civilization—A Case of Shandong Province, China

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Abstract According to the connotation of ecological civilization, construction principle of ecological civilization index system is expatiated, including integrity principle, applicability and feasibility principle, quantification principle and purposefulness principle. Based on this, a total of 23 single factors are selected from four aspects of ecological environmental protection, economic development, social progress and environmental protection consciousness. Ecological civilization index system is constructed. Weight of single factor is determined by using Analytic Hierarchy Process (AHP) and comprehensive evaluation model is established. Taking Shandong Province as an example, optimized index system and comprehensive evaluation model are used to analyze the ecological civilization construction level of Shandong Province. Result shows that scores of ecological environmental protection, economic development, social progress and environmental protection consciousness are 47.24, 71.05, 37.57 and 77.57, respectively, with the integrated score of ecological civilization being 61.35, indicating that ecological civilization degree of Shandong Province is at the preliminary state of civilization. Major factors restricting the development degree of ecological civilization are ecological environmental protection, social progress and so on. At present, we should reduce the fertilizer and pesticide application, control the growth rate of population and increase investment in education.

Key words Ecological civilization; Index system; Ecological environmental consciousness; Shandong Province, China

Since the 16th Party Congress, the party has attached great importance to ecological and environmental construction during the realization of the country's rapid economic growth. It has also put forward the concept of scientific development, harmonious society, ecological civilization and other ruling concepts in order to achieve the harmonious development between man and nature. The government report on the 16th Party Congress has put forward new requirements for the construction of a comprehensive well-off society in future, so as to establish the industrial structure, growth pattern and consumption mode which can save energy resources and protect the ecological environment. Ecological civilization is an important basis for achieving sustainable development; and establishing a workable ecological civilization index system is of certain reference value for the comprehensive construction of well-off society in China^[1]. Jiang Xiaoping has selected a total of 20 indices in 3 categories of eco-environmental protection, economic development and social progress to construct the evaluation system, taking Henan Province as an example^[2]. Evaluation index system of ecological civilization does not involve subjective factors, such as eco-environmental awareness, and can not fully reflect the meaning of ecological civilization. Therefore, we try to construct a relatively perfect evaluation index system from the connotation of ecological civilization.

1 Connotation of ecological civilization

Ecological civilization refers to the sum of physical, spiritual

and system results achieved through constructing an orderly ecological operation mechanism and good ecological environment, through continuously overcoming the negative effects of the transformation process and through actively improving the interpersonal relationships and relationship between human beings and nature when rebuilding the objective material world. According to its connotation, ecological civilization includes strong ecological awareness, good ecological environment, sustainable economic development mode and perfect ecological system^[3].

2 Construction principle of ecological civilization index system

2.1 Principle of integrity Index system should reflect the main connotation of ecological civilization, covering the content of ecological awareness, ecological environment, economic development and social development and reflecting the integrity of ecological civilization.

2.2 Principle of applicability and feasibility Establishment of index system should consider the possibility of reality, the difficulty of data collection, and the consistency and authenticity of data statistics. Index selection should use the available data within evaluation period as far as possible.

2.3 Principle of quantification Indices in the index system should use quantitative index as far as possible in order to ensure the accuracy of evaluation results. The indices difficult to be qualified can be briefly introduced, but should not be included in the evaluation system.

2.4 Principle of purposefulness Principle of purposefulness is the fundamental starting point to establish index system. Index system should be the objective description of essential characteristics, structure and constituent elements of assessment object, as well as the purpose service of evaluation activities.

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3 Construction of ecological civilization index system

3.1 Basic framework Under the guidance of the construction principles of ecological civilization, index system of ecological

civilization is established from three aspects of economic development, social progress, ecological and environmental protection (Table 1).

Table 1 Evaluation index system of ecological civilization

Target layer	Criteria layer	Factor layer
Evaluation of ecological civilization level A	Ecological and environmental protection B1	Forest coverage C1 // %
		Per capita urban public green area C2 // hm ² /people
		Proportion of nature reserve area in provincial area C3 // %
		Control rate of land with soil and water loss C4 // %
		Standard-reaching rate of industrial wastewater C5 // %
		Carbon dioxide emission per ten thousand yuan GDP C6 // kg/ × 10 ⁴ yuan
		Standard-reaching rate of water environmental functional district in main rivers C7 // %
		Comprehensive utilization ratio of industrial solid waste C8 // %
		Harmless treatment rate of urban garbage C9 // %
		Fertilizer application in unit cultivated area C10 // kg/hm ²
		Pesticide application in unit cultivated area C11 // kg/hm ²
		Energy consumption per ten thousand yuan GDP C12 // t/ × 10 ⁴ yuan
		Proportion of pollution control investment in GDP C13 // %
	Economic development B2	Per capita GDP C14 // yuan/people
		Annual per capita net income of farmer C15 // yuan/people
		Annual per capita disposable income of urban household C16 // yuan/people
		Proportion of tertiary industry C17 // %
	Social progress B3	Natural population growth rate C18 // ‰
		Urbanization level C19 // %
		Number of college students in every ten thousand people C20 // people
	Environmental protection consciousness B4	Cognition degree of environmental protection and ecological civilization C21 // score
		Citizen's attitude toward environmental protection C22 // score
		Citizen's eco-civilized behavior C23 // score

In the index system, index of ecological civilization is composed of four criteria layers, including ecological and environmental protection, economic development, social progress and environmental protection consciousness. Layer of ecological and environmental protection has in all 13 indices. Among them, forest coverage, per capita urban public green area, proportion of nature reserve area in provincial area, and control rate of land with soil and water loss can reflect the status of terrestrial ecosystem. Standard-reaching rate of industrial wastewater, and standard-reaching rate of water environmental functional district in main rivers can reflect the status of water environment. Carbon dioxide emission per ten thousand yuan GDP reflects the situation of regional air quality. Comprehensive utilization ratio of industrial solid waste and harmless treatment rate of urban garbage can indicate the status of solid waste. Fertilizer application in unit cultivated area and pesticide application in unit cultivated area show the status of soil. Energy consumption per ten thousand yuan GDP and proportion of pollution control investment in GDP can reflect the strength of environmental protection investment. Layer of economic development has in all 4 indices. Among them, per capita GDP, annual per capita disposable income of urban household and annual per capita net income of farmer can indicate the economic productivity. Proportion of tertiary industry reflects the status of economic structure. Layer of social progress has in all 3 indices. Among them, natural population growth rate reflects the concept of residents. Urbanization level indicates the status of construction development. And number of college students in

every ten thousand people shows the local cultural conditions. Layer of environmental protection consciousness also have 3 indices. Among them, cognition degree of environmental protection and ecological civilization reflects the basic knowledge of environmental protection. Citizen's attitude toward environmental protection shows the environmental consciousness of citizens. And citizen's eco-civilized behavior reflects the implementation status of environmental protection consciousness.

3.2 Evaluation index weight and comprehensive evaluation model

3.2.1 Determination of evaluation index weight by AHP method. Weight can reflect the action intensity of evaluation factors on land use status and can highlight the effect of main factors on evaluation result. AHP method is used so that experts can evaluate the importance of evaluation factors starting from the connotation of ecological civilization. After consistency test, weight of indices can finally be obtained (Table 2–6).

Table 2 Judgment matrix of target layer and criteria layer

A	B1	B2	B3	B4	Weight
B1	1				0.351 4
B2	1/2	1			0.188 8
B3	1/3	1/2	1		0.108 5
B4	1	2	3	1	0.351 4

Note: Maximum eigenvalue $\lambda = 4.005$; consistency index $CI = 0.002$; average random consistency index $RI = 0.90$; consistency ratio $CR = 0.002 < 0.10$.

Table 3 Judgment matrix of criteria layer *B1* and its associated factor

<i>B1</i>	<i>C1</i>	<i>C2</i>	<i>C3</i>	<i>C4</i>	<i>C5</i>	<i>C6</i>	<i>C7</i>	<i>C8</i>	<i>C9</i>	<i>C10</i>	<i>C11</i>	<i>C12</i>	<i>C13</i>	Weight
<i>C1</i>	1													0.083
<i>C2</i>	1/2	1												0.045
<i>C3</i>	1/3	1/2	1											0.027
<i>C4</i>	1	2	3	1										0.083
<i>C5</i>	1/2	1	2	1/2	1									0.045
<i>C6</i>	3	4	5	3	4	1								0.209
<i>C7</i>	2	3	4	2	3	1/2	1							0.123
<i>C8</i>	1	2	3	1	2	1/3	1/2	1						0.083
<i>C9</i>	1	2	3	1	2	1/3	1/2	1	1					0.083
<i>C10</i>	1/2	1	2	1/2	1	1/4	1/3	1/2	1	1				0.045
<i>C11</i>	1/2	1	2	1/2	1	1/4	1/3	1/2	1	1	1			0.045
<i>C12</i>	1	2	3	1	2	1/3	1/2	1	2	2	2	1		0.083
<i>C13</i>	1/2	1	2	1/2	1	1/4	1/3	1/2	1	1	1	1/2	1	0.045

Note: $\lambda = 13.091$; $CI = 0.008$; $RI = 1.56$; $CR = 0.005 < 0.10$.

Table 4 Judgment matrix of criteria layer *B2* and its associated factor

<i>B2</i>	<i>C14</i>	<i>C15</i>	<i>C16</i>	<i>C17</i>	Weight
<i>C14</i>	1				0.456
<i>C15</i>	1/2	1			0.263
<i>C16</i>	1/3	1/2	1		0.141
<i>C17</i>	1/3	1/2	1	1	0.141

Table 5 Judgment matrix of criteria layer *B3* and its associated factor

<i>B3</i>	<i>C18</i>	<i>C19</i>	<i>C20</i>	Weight
<i>C18</i>	1			0.5
<i>C19</i>	1/2	1		0.25
<i>C20</i>	1/2	1	1	0.25

Note: $\lambda = 3.000$; $CI = 0$; $RI = 0.58$; $CR = 0 < 0.10$.

Table 6 Judgment matrix of criteria layer *B4* and its associated factor

<i>B4</i>	<i>C21</i>	<i>C22</i>	<i>C23</i>	Weight
<i>C21</i>	1			0.540
<i>C22</i>	1/2	1		0.297
<i>C23</i>	1/3	1/2	1	0.163

Note: $\lambda = 3.006$; $CI = 0.003$; $RI = 0.58$; $CR = 0.005 < 0.10$.

3.2.2 Establishment of comprehensive evaluation model. Based on the index weight, comprehensive evaluation model of ecological civilization can be established.

$$P = \sum_{i=1}^{23} W_i V_i \times 100,$$

where P is the comprehensive evaluation of ecological civilization, W_i is the weight of factor i , and V_i is the evaluation score of index i . During the determination of score, non-dimensional treatment on single index should be carried out in order to determine the score of each single index and to compare the single index. Evaluation score = present value of index / target value of index. The smaller variable value of index indicates the higher level of ecological civilization. Evaluation score = target value / present value of index.

Degree of ecological civilization can be divided into less civilization, preliminary civilization, primary civilization and ex-

treme civilization, with the corresponding P values being <60 , $60-75$, $75-90$ and >90 .

Table 7 Index system value and weight of ecological cultivation in Shandong Province

Target layer <i>A</i>	Criteria layer <i>B</i>	Index layer <i>C</i>	Present value	Target value	Weight of <i>C</i> to <i>B</i>
Evaluation of ecological civilization degree	Ecological and environmental protection	<i>C1</i>	25.50	≥ 35	0.083
		<i>C2</i>	13.33	≥ 20	0.045
		<i>C3</i>	6.49	≥ 10	0.027
		<i>C4</i>	68.90	≥ 90	0.083
		<i>C5</i>	98.07	100	0.045
		<i>C6</i>	7.01	≤ 6.0	0.209
		<i>C7</i>	32.62	100	0.123
		<i>C8</i>	97.32	100	0.083
		<i>C9</i>	80.71	100	0.083
		<i>C10</i>	707.00	≤ 255	0.045
		<i>C11</i>	23.40	≤ 1	0.045
		<i>C12</i>	1.18	≤ 0.3	0.083
		<i>C13</i>	0.26	≥ 1.0	0.045
	Economic development	<i>C14</i>	27 807	$\geq 33\ 000$	0.456
		<i>C15</i>	4 985	$\geq 8\ 000$	0.263
		<i>C16</i>	14 265	$\geq 24\ 000$	0.141
		<i>C17</i>	33.43	≥ 60	0.141
	Social progress	<i>C18</i>	3.58	≤ 0.5	0.500
		<i>C19</i>	46.80	≥ 50	0.250
	Environmental protection awareness	<i>C20</i>	143.70	≥ 500	0.250
		<i>C21</i>	57.6	≥ 80	0.540
		<i>C22</i>	62.4	≥ 80	0.297
		<i>C23</i>	76.2	≥ 80	0.163

Note: Present value refers to the data of 2007. Data are from 2008 Shandong Statistical Yearbook. Environmental protection awareness values are from the investigation on resident awareness of ecological civilization in 85 villages in Shandong Province^[4]. Target value has consulted the construction goal of ecological province in China, as well as the domestic advanced level.

4 Analysis on the construction level of ecological civilization in Shandong Province

The index system of ecological civilization constructed by Jiang Xiaoping is not comprehensive enough. And its calculation model is unable to give the final conclusions of the ecological civilization^[1]. Therefore, we revise the index system and add some subjective factors, such as environmental protection consciousness. Comprehensive evaluation model is also used based on the indices of Shandong Province in the year 2007, in order to evaluate the status of ecological civilization in Shandong Province. It is obtained that the weights of criteria layers *B1*, *B2*, *B3* and *B4* on target layer *A* are 0.351 4, 0.188 8, 0.108 5 and 0.351 4, respectively. And Table 7 reports the rest correlation values.

According to comprehensive evaluation model, the scores of ecological and environmental protection, economic development, social progress, and environmental protection awareness, are 47.24, 71.05, 37.57 and 77.57, respectively, with the integrated score of ecological civilization being 61.35, indicating that ecological civilization degree of Shandong Province

is at the preliminary state of civilization. Among the four criteria, there are urgent needs to improve ecological and environmental protection and social progress.

5 Conclusion

Index system of ecological civilization put forward by Jiang Xiaoping is optimized. And subjective factors, such as environmental protection awareness are, fully considered. Through a series of method improvement, weight of ecological civilization factor can be determined scientifically. Ecological civilization degree and its four components are quantified and classified. Thus, the research result is intuitive and scientific.

In the year 2007, ecological civilization degree of Shandong Province is at the state of preliminary civilization. Main factors restricting the development of ecological civilization are the social progress and the ecological and environmental protection measures. Shandong Province should further reduce the fertilizer and pesticide use, control the growth rate of population and intensify education strength in future.

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省域生态文明评价体系的构建——以山东省为例

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摘要 从生态文明的内涵出发,阐述了生态文明指标体系的构建原则,即整体性原则、适用性和可行性原则、量化原则、目的性原则。在此基础上,从生态环境保护、经济发展、社会进步、生态环保意识4个方面选择了23项单项因子,构建了生态文明指标体系。运用层次分析法确定了单项因子的权重,并建立了综合评价模型。以山东省为例,利用优化的指标体系和综合评价模型分析了山东省的生态文明建设水平。结果表明,山东省生态环境保护程度、经济发展、社会进步、生态环保意识4方面的得分值分别为47.24、71.05、37.57、77.57分,生态文明的综合得分值为61.35分,说明山东省生态文明程度处于初级文明状态,制约生态文明发展程度的主要因素为生态环境保护措施和社会进步等,现阶段,应进一步减少化肥和农药的施用量、控制人口增长率、加大教育投入力度。

关键词 生态文明;指标体系;生态环保意识;山东省

(From page 4)

农村土地承包经营权流转的农村社会保障供求矛盾解决途径——以河北省为例

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摘要 首先,以河北省土地流转为例,介绍了河北省农村土地承包经营权流转现状。其次,采用抽样调查法,对河北省350户参与土地转出的农户的社会保障供求状况进行调研,分析了河北省土地流转前后农村社会保障供求状况。其中,从土地转出前农户的社会保障供给状况、土地转出后农户的社会保障供给状况(农户养老保障状况、农户医疗保障状况、农户就业保障和教育培训状况)2个方面探讨了河北省土地流转前后农村社会保障供给状况;从土地转出后农户的社会保障需求状况、土地转出前农户的社会保障需求状况2个方面分析了河北省土地流转前后农户的社会保障需求变化状况。最后,提出了通过加大针对合作医疗资助力度、出台针对土地流转的相应社会保障政策、建立农村社会保障的管理、执行、监督机构,以及树立农民现代社会保障意识的措施来解决土地流转过程中农村社会保障供求矛盾,并建议政府应以优化和完善转出土地农民的社会保障制度为目的,建立一个统一的覆盖全省农民的社会保障体系。

关键词 农村土地承包经营权;土地流转;土地转出;社会保障