

Research on the Construction and Application of Auditing Evaluation Index of Ecological Environment Performance in Resource-based Cities

A Case Study of Xuzhou City

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Abstract—Resource-based cities generally have a problem of ecological environment deterioration, and need more environmental protection efforts of the relevant government departments and the supervision and restriction of the audit department in the process of environmental improvement, economic transformation and upgrading, ecological civilization construction. In consideration of current eco-environmental performance audit being still in the exploratory stage and the evaluation index constituted having strong generality, this paper collects the basic information of ecological environment in Xuzhou City and uses the PSR model to constitute the auditing evaluation index system of environmental performance based on ecological civilization construction, and uses the goal-oriented method to give a score of the evaluation indices and finally gets the comprehensive performance of ecological civilization in Xuzhou City. This study provides a systematic evaluation index system for environmental performance auditing, and offers an important reference for performance auditing evaluation.

Keywords—resource-based city; ecological civilization construction; performance auditing evaluation index

I. INTRODUCTION

Resource-based city is a major support of China for important energy supply and economic development, and has made great contributions to the development of national economy. However, since the reform and opening up, extensive development led to various contradictions and problems in an endless stream. According to the assessment criteria of "Sustainable Development Plan of National Resource-Based Cities", 26% of resource-based cities in China have a resource decline, with resource reserves increasingly depleted. The provincial and municipal governments are increasingly aware of the importance of environmental protection, continuously put forward environmental protection policy. On December 22, 2016, General Office of the CPC Central Committee and General Office of the State Council issued the "Evaluation and Assessment Method of Ecological Civilization Construction Target", to list ecological civilization into the performance assessment. The governmental functions in ecological environment have

promoted the development of environmental performance auditing. At present, China has carried out relatively few environmental performance audits, mainly focusing on financial auditing and limited to the auditing supervision of special funds of environmental protection, in lack of the supervision of environmental policy implementation as well as the economy, efficiency and effectiveness of ecological civilization construction.

II. LITERATURE REVIEW

With the development of eco-environmental performance auditing practice in China, the academic community has also carried out research on environmental performance auditing evaluation index. The main research results: the comprehensive evaluation index system of environmental performance auditing is constructed by Ren Yanhong et al. (2013), for which they use the AHP method and take a comprehensive consideration of economy, society and environment and select indicators from six aspects of ecological environment quality, pollution control, environmental construction, resource and energy utilization, total pollutant emission reduction and public satisfaction [1]; the index system is conducted by Meng Zhihua et al. (2014), for which they accord to the economy, efficiency and effectiveness of governmental performance auditing in environmental management and take account of the executive benefit of environmental protection, the sale of environmental protection investment and the level of environmental quality, meanwhile they combine the frequency analysis method and the questionnaire method to determine the specific evaluation indicators [2]; the evaluation index system of ecological security in resource-exhausted cities is conducted by Tao Xiaoyan (2014), for which she depends on the PSR conceptual model, refers to the existing urban ecological security evaluation index system, take account of the actual situation of resource-exhausted cities, follow the principles of scientificity, practicability, comprehensiveness and operability, starts from three aspects of pressure (population resources, environment, society), state (economy, energy, resources, environment), response (economy, environment, human culture) [3]; the expansive application of environmental performance

【CLC】 F239.42 【Document code】 A.

evaluation standard in the macro region from the microstructure is conducted by Qin Dezhi et al. (2015), for which they synthesize the theory of balanced scorecard to design the environmental performance auditing index framework of regional government as the three types of indicators including environmental quality index, developmental and environmental index, decision-making and action index, with a causal relationship among these indicators, effectively reflecting the sustainable development goal [4]; the scientific performance auditing evaluation system for ecological environment in Tianjin is conducted by Duan Zhu et al. (2016), for which they analyze the characteristics of ecological environment in Tianjin, and select the eligible indicators from two dimensions of commonness (input, management, output) and individuality (monitoring ability, pollution control, ecological construction, environmental protection project and environmental protection participation) [5]; the low-carbon auditing evaluation index system is conducted by Chen Yangyang et al. (2016) to make a comprehensive assessment of low-carbon performance audit and promote energy conservation and emission reduction, for which they takes into account the complexity of low-carbon audits, use the AHP method, start from the five viewpoints of economic benefit and related costs of carbon activities (economic benefits), carbon emissions (low carbon consumption), carbon emissions management activities (low carbon technology), low carbon social responsibility (environmental protection), scientificity and executive efficiency of policy (low carbon policy) [6].

In summary, some research results have been made in study on environmental performance auditing practice and theory. In the evaluation system, indicators are built from all various angles, for which the analytic hierarchy process, frequency analysis method and questionnaire combination as well as the "pressure - state - response" model and balanced scorecard method are used, but the environmental performance audit as a new area of audit is generally still in the initial stage of study. First, most of the evaluation system is open and universal, in lack of regional embeddability, with bad operability; second, the environmental evaluation index is more, and the ecological environment performance audit evaluation indicator of resource-based cities and other special cities is lacking. Therefore, it is necessary to carry on the systematic environmental performance audit research for the resource-based cities and design the environmental performance audit evaluation index according to the ecological characteristics and the construction of ecological civilization to enrich the environmental performance audit theory system and serve the environmental performance audit practice.

III. THE CONSTRUCTION OF INDICATORS

PSR (Pressure State Response) model is a more commonly used in the evaluation of environmental management and it is a framework system used by the United Nations Environment Program (NUEP) and the Organization for Economic Cooperation and Development (OECD) to study environmental resources [7]. Among these, the pressure index is the beginning of the whole ecological environment change, the state index means the state of the pressure, and the response index refers to the environmental protection measures

for the pressure and the state. Xuzhou is the only coal resource city in Jiangsu Province, but the long-term exploitation of coal caused a subsidence of near ten thousand hectares of coal mine. Facing the pressure of Xuzhou ecological environment management, the governmental departments of all functions implemented the environmental renovation and improvement, ecological restoration, transformation and upgrading and other policies, to achieve a great change from "full of dust in a coal city" into "scattered with lakes in a green city" and successfully create it into a national ecological garden city. In this paper, the PSR framework model is used to select the environmental performance auditing evaluation index, with the integration of the dynamic process of environmental change and the performance auditing, showing the results of ecological civilization construction in Xuzhou in all directions and throughout the whole process.

A. The Principle of Indicator Construction

In the view of ecological civilization, the evaluation index of ecological environment performance of resource-based cities can measure the level and effect of ecological civilization construction in a certain period. It is the symbol of sustainable development and the basis of quantitative comparison. Therefore, in the selection of indicators, we must follow the following principles:

1) *Valuable*: Ecological environment performance audit should be done on the basis of the normative document for evaluation, and select the representative indicators from the "Indicators of National Ecological Civilization Construction Demonstration County and City", "Xuzhou City Ecological Civilization Construction Plan" and "Xuzhou City Air Pollution Control Action Plan" to make clear evaluation criteria, and ensure the indicators are easily obtained and mastered by auditors.

2) *Concrete*: Ecological environment performance audit and environmental performance have many common aspects in the audit, so when we design some universally applicable general indicators in the construction of eco-environmental performance auditing evaluation index for the resource-based cities, and select the strong-targeted individual indicators according to the characteristics of ecological civilization construction in the resource-based cities, to subdivide the environmental improvement tasks into specific projects and enhance the operability.

3) *Objective*: Auditing evidence is the key to control the quality of audit work, must not be affected by auditors and other personnel, and in order to reduce the audit risk, we should exclude the qualitative content of subjective judgment, to enhance the comparability of indicators, and should completely select the objective quantitative indicators for the indicators setting, to avoid one-sided evaluation and improve the quality of evaluation.

4) *Performable*: The ultimate goal of environmental performance auditing is to promote the audited area to fast change its laggard way in the economic development, to accelerate the economy, efficiency and effect in the ecological civilization construction, and to realize the coordination of environment and development and keep sustainable

development. We should compare the expected objectives and the actual operation results of the ecological civilization construction project, analyze the effect of ecological civilization construction in the functional departments, find out the problems in the implementation and the solutions.

B. The Initial Selection of Indicators

1) *Pressure (P) indicator*: Xuzhou City makes a long-term "depredatory" mining to cause a serious damage to the environment, so it has multiple pressures in the ecological civilization construction, including environmental renovation and improvement, ecological reconstruction, economic transition. Therefore, we should select the emissions of waste water, waste gas and the main pollutants, solid waste generation and GDP ratio, waste area of industrial mining, GDP energy consumption in a unit and other indicators to reflect the pressure of ecological civilization construction.

The higher pressure indicator indicates more pressure on the environment caused by the pollution emission in the process of economic development, and more cost for pollutant discharge in the production of GDP of a unit, that is, the P indicator is reverse, and if the index value is greater, it is more adverse for the improvement of natural resources and environmental conditions [8].

2) *State (S) indicator*: According to the environmental pressure generated by urban development, set the corresponding environmental state; for the ecological damage pressure and the economic transition pressure caused by mining in the resource-based cities, the state reflected should respectively includes the forest coverage and the added value proportion of the tertiary industry in GDP.

The higher state indicator indicates better quality improvement of water and atmosphere, that is, the S indicator is positive, and if the index value is greater, the environmental state and the natural resources are improved better.

3) *Response (R) indicator*: The response measures for pressure and state are dependent on the coordination of financial input and governmental functions. Therefore, the response indicators are mainly related to the various inputs for environmental renovation and improvement, ecological investment, the cooperation of relevant functional departments and the resulting ecological civilization performance, and this paper constructs the response indicators from three dimensions of financial response, function response and effect response.

The construction of ecological civilization requires the support of a large number of special funds. The financial response state should be done by selecting the proportion of various environmental fund investment in GDP according to the input intensity of funds and by measuring the pressure of the relevant departments for environmental pollution.

For functional response indicators, change the qualitative indicators into specific governance measures and make quantitative assessment according to the duties of the functional departments stipulated in the "Ecological Civilization Construction Plan of Xuzhou City" and the "Air Pollution Control Action Plan of Xuzhou City". For the water

pollution control, the Water Conservancy Bureau and the Environmental Protection Agency are responsible for promoting the pollution control projects construction and the comprehensive improvement of urban river environment issued by the provincial government. for atmospheric environment improvement, the Environmental Protection Agency and the Quality Supervision Bureau are responsible for the comprehensive rectification of small coal-fired boilers; the Public Security Bureau, the Bureau of Transportation and the Environmental Protection Agency speed up the elimination of old vehicles and strengthen the environmental management of motor vehicles; the Environmental Protection Agency, the Commission of Economy and Informatization, the Agriculture Committee and the audit department carry out the clean production performance auditing of key enterprises and fully examine the implementation of three simultaneous measures. For ecological restoration, the Agriculture Commission, the Environmental Protection Agency, the Bureau of Gardens and other departments promote the comprehensive utilization of straw, mechanized return of straw to field, mainly control the soil erosion caused by coal mine collapse, and improve the reclamation and use of industrial and mining waste area.

The effect response indicator is the final effect of various measures. In combination with the problems shown by pressure and state indicators, and in reference of the goal of ecological civilization construction, we can determine the effect response indicator in four aspects: the effect of water environment improvement, the effect of atmospheric environment improvement, the effect of circular development of industry and the effect of ecological civilization construction.

The higher response indicator indicates more attention of the local government to the environmental management of the ecological city. The pollution control action is stronger, the effect is better, that is, the R index is positive, and if the index value is higher, it is more propitious to the improvement of natural resources and environmental conditions.

Based on the above analysis, the initial evaluation index system is constructed. Through the questionnaire survey, we consult the opinions of experts of the environmental protection department and the audit department, screen and integrate the preliminary index system, and then make a comprehensive consideration of the rationality, operability and concreteness of indicators, ad finally determinate 37 evaluation indicators. the indicators are established as in "Table II".

IV. THE DETERMINATION OF INDEX SCORES

A. Determine the Weight of the Indicators

The weight of each index is decided according to the principle of importance, that is, more important indicator has greater weight, and the specific value of index adopts the method of scoring by expert; through the questionnaire survey and the two-two comparison, experts give scores for each indicator; the experts include the auditors of government agencies, the staff of environmental protection departments and the scholars of university, totaling 10 persons. According to the importance coefficient of each indicator assessed by the

experts, the average value is calculated, and its proportion of the total score is taken as the weight of each index.

B. Determine the Scores of the Indicators

Calculate the weight according to the scores given by the experts, and make a conversion as per percentage system, and get the score of each indicator "Table I".

TABLE I. WEIGHT STATISTICS AND WEIGHT CALCULATION TABLE

Evaluated Indicators	Expert's Scoring Results				Total score	Average score	Weight	Score after adjustment
	1	2	...	10				
P11	93	92		95	932	93.2	0.035	3.50
P12	89	87		85	870	87	0.033	3.33
...								
R312	65	54		55	576	57.6	0.022	2.16
Total	2664	2664		2664	26640	2664	1.00	100

V. THE APPLICATION OF EVALUATION INDEX SYSTEM

Scientific and reasonable evaluation system depends on the appropriate evaluation method, and this paper chooses the target evaluation method, compares the actual value and the target value of ecological civilization construction, analyzes the reason of the difference, and further evaluates the overall performance of ecological environment.

A. Determine the Target Value

determine the target value according to the "Implementation Program of Air Pollution Control Action Plan of Xuzhou City (2014)", the "Indicators of National Ecological Civilization Construction Demonstration County and City" and the annual plan of Xuzhou City; and for the indicators that

have no assessment target published, determine its target value according to the data in the previous year.

B. Determine the Actual Value

In the auditing practice, the actual value should be obtained by auditors through the implementation of auditing process, but this paper obtains the relative information for the evidence of final authentication of performance audit according to the data published in the "Jiangsu Statistical Yearbook 2015" and "Xuzhou Environmental Bulletin 2014" and by consultation of the relevant departments because the audit department of Xuzhou City has not carried out the ecological and environmental performance auditing currently.

TABLE II. THE ECO-ENVIRONMENTAL PERFORMANCE AUDITING EVALUATION INDEX SYSTEM OF XUZHOU CITY

Project Level	Criterion Level	Index Type	Evaluation Index	Evaluation Criteria Source and Score	Scoring		Score
					Target value	Actual value	
<i>The eco-environmental performance auditing evaluation of Xuzhou City</i>	Pressure	Pressure in Water Environment (P1)	P11 Unit GDP Wastewater Emission Intensity	C 3.50	1.059	0.867	2.90
			P12 Unit GDP Chemical Oxygen Demand Emission Intensity	B 3.33	2.78	2.661	2.55
			P13 unit GDP ammonia-nitrogen emission intensity	B 3.30	0.32	0.27	2.81
		Pressure in Atmospheric Environment (P2)	P21 Unit GDP Waste Gas Emission intensity	C 3.51	1.169	1.106	2.45
			P22 Unit GDP sulfur dioxide Emission Intensity	B 3.45	3.49	2.273	3.45
			P23 Unit GDP nitrogen oxide Emission Intensity	B 3.38	5.69	3.773	3.38
			P24 Unit GDP Dust Emission Intensity	C 3.49	1.317	1.506	1.75
		Pressure in Soil Environment (P3)	P31 Unit GDP Solid waste generation	C 2.89	0.314	0.30	2.17
		Pressure in Ecological Restoration (P4)	P41 abandoned industrial mining area	C 3.45	5380	7800	1.90
		Pressure in Economic Transition (P5)	P51 Unit GDP Energy consumption	A 3.31	0.7	74	1.92
		Subtotal of pressure indicators			33.55		25.28
	State	Environmental state (S1)	S11 water environment quality	A 4.05	70	76.6	2.55
			S12 rate of excellent air quality	A 4.23	85	65.6	2.12
			S13 proportion of unpolluted Soil area	B 3.81	90	81	2.86
		Ecological state (S2)	S21 Forest coverage	A 4.30	13	16.2	4.09
		Economic Transition (S3)	S31 the proportion of added value of tertiary industry to GDP	A 3.98	55	45.21	2.15
		Subtotal of state indicators			20.38		13.76

Project Level	Criterion Level	Index Type		Evaluation Index	Evaluation Criteria Source and Score	Scoring		Score	
						Target value	Actual value		
The eco-environmental performance auditing evaluation of Xuzhou City	Response	Financial response (R1)		R11 Investment Rate of Environmental Governance	C 1.88	1.01	0.55	1.03	
				R12 greening and eco- - environmental capital investment rate	C 1.95	0.002	0.01	1.76	
		Functional response (R2)	Comprehensive governance	R21 "three simultaneous" rate of environmental protection project	A 2.38	100	100	2.38	
				R22 pollution source on-line monitoring system construction rate	A 1.81	100	100	1.81	
			Water treatment	R23 quantity of completed river course for renovation and improvement	B 1.88	11	7	1.26	
			Atmospheric Governance	R24 quantity of dismantled or reconstructed coal-fired boilers	B 2.10	80	155	2.10	
				R25 quantity of eliminated yellow label vehicles	B 2.26	36056	41000	1.92	
				R26 clean production acceptance rate of enterprises	B 2.36	100	100	2.36	
			Ecological management	R27 soil erosion control area	B 2.55	45.6	45.6	1.53	
				R28 new afforestation area	A 2.58	9000	9400	1.81	
		Effect response (R3)	Water environment improvement	R31 sewage treatment compliance rate	A 1.95	80	89	1.60	
				R32 chemical oxygen demand reduction rate	B 1.84	3.7	4.53	1.69	
				R33 Ammonia- nitrogen reduction rate	B 1.58	2.7	3.78	1.50	
			Atmospheric environment improvement	R34 sulfur dioxide reduction rate	B 1.80	13.8	17.07	1.64	
				R35 nitrogen oxides reduction rate	B 1.69	19.3	27.65	1.69	
				R36PM2.5 average concentration eduction rate	B 1.80	5	12.6	1.80	
			Construction of ecological civilization	R37 per capita park greening area	A 2.76	13	16.2	2.71	
				R38 green coverage of built area	A 2.16	36	43.3	1.92	
				R39 coverage rate of ecological township	A 2.21	80	95	2.10	
			Industrial cycle	R310 People 's Satisfaction with Ecological Civilization Construction	A 2.30	80	87.1	1.84	
				R311 comprehensive utilization rate of industrial solid waste	B 2.06	80	99.19	2.06	
				R312 comprehensive utilization rate of straw	B 2.16	88	89	1.77	
		Subtotal of response indicators				46.07			40.28
		Total				100			79.33

^a. (Note: the source of evaluation criterion A refers to " Indicators of National Ecological Civilization Demonstration County and City", B refers to the annual target, C refers to the data in the previous year.

C. The Overall Score

for the concrete scoring process, this paper adopts the experimental research method, for which the questionnaires are given out to five auditors for making a analogue scoring of the evaluation standard, the target value and the actual value according to their professional judgment, and calculates the average value of the scores given by the five experts and then gets the scores of the indicators "Table II".

VI. CONCLUSION AND SUGGESTION

Generally the evaluation results of ecological environment performance audit can be divided into five categories: "excellent", "good", "medium", "poor" and "bad". 90 ~ 100 is "excellent", 75 ~ 90 is "good", 60 ~ 75 is "medium", 45~ 60 is "poor", and below 45 is "bad". The comprehensive performance score of Xuzhou City is 79.33 points, which indicates that the comprehensive performance

evaluation of the city is good. Wholly, Xuzhou City takes more environmental management response measures in response to the pressure on the environment and resources, to make the comprehensive environmental performance in a good state, basically meeting the standards for ecological and civilized city. In the water environment, it implements the integrated management of riverway environment, the improvement of feculent ditch and other projects, to make the regional water quality improved continuously and complete the annual task of water pollution prevention and control. In the atmospheric environment, it improve air quality first from the pollution source, demolishes or reconstructs the coal-fired boilers, eliminates the yellow label vehicles and old vehicles and takes other measures together, over fulfills the annual emission reduction task; but Xuzhou City is a city of coal consumption, the development and utilization of mineral resources leads to excessive dust emissions in the air, to make the air quality still falls short of

the indicator requirements of national ecological civilization city constructions, and it is difficult to radically solve the air pollution problem. In the natural resources, in order to create a national ecological garden city, it strengthens the greening and eco-environmental capital investment and improves the level of whole landscape virescence. However, the destruction of ecological environment caused by coal mining is still the most important factor in environmental management. In the industrial upgrading, the industrial structure is single, excessive consumption of resources promotes the rapid economic growth, and the weak development of alternative industries seriously restricts the sustainable development of economy.

For the above conclusions, this paper proposes the following suggestions:

First, in the financial investment, the governments at all levels should take ecological civilization construction and environmental protection as an important part of fiscal budget expenditure, increase investment in environmental governance, ensure the continuous growth of investment in ecological civilization construction and in environmental protection, and strengthen the management of fund use efficiency.

Second, in the economic transformation, get rid of the coal economic growth type based on excessive consumption, develop the incentive policies of clean energy development and use, cultivate the industries of photovoltaic, biomass energy and other new energy; promote the structural reform of the supply-side, eliminate the outdated production capacity, increase the proportion of added value of the tertiary industry to GDP, promote the ecological development of economy; support the development of circular economy, speed the technical innovation of environmental protection, improve the comprehensive utilization of straw, solid waste and other waste, advance the industrial recycling and sustainable development.

Third, in the ecological restoration, set up the long-term goals, carry out ecological protection compensation mechanism, increase the reclamation of industrial and mining waste land, actively control the soil erosion caused by coal mining, mobilize the enthusiasm of all parties, increase publicity and guide the public participation in the construction of ecological civilization.

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