The 18th Biennial Conference of International Society for Ecological Modelling

Evaluation of the Conservation Culture Development in Shandong Province, China

J. H. Zhou, P. L. WU*

School of Business Studies, Shandong University at Weihai, 180 Wenhua Xilu, Weihai, Shandong, 264209 China

Abstract

As conservation culture turns to be a public issue in China, an increasing number of scholars and agencies are dedicating to studying and building the conservation culture index to evaluate regional conservation culture development. Shandong, a province with large population, booming economy, and scarce land and water resources, should well recognize its status quo and trend of conservation culture construction for a sustainable future. According to local natural conditions and socio-economic development status of the 17 cities in Shandong, the authors firstly select 18 indicators from a wide range covering natural resources, social and economic development, and environment conditions, and build a conservation culture index system. Next, we standardize the values of all indicators and calculate the sub-indices of conservation culture in three dimensions, economic and social structure, resources and environmental function, and coordination degree between human and nature. Then, we weight the three sub-indices, comprise the conservation culture index of each of the 17 cities, and assess their conservation culture development levels. Finally, based on the assessment and grading of conservation culture development levels of the 17 cities, the authors put forwards some corresponding countermeasures to integrate social, economic and ecological development, and further upgrade the conservation culture development of the province.

© 2011 Published by Elsevier B.V.

Keywords: Conservation culture; Index system; Evaluation methodology; Shandong province

1. Introduction

Shandong is one of the most important provinces in China. It is located on the eastern edge of the North China Plain and in the lower reaches of the Yellow River. Its east part extends out to sea in the

* Corresponding author. Tel & fax: +86-631-568-8289.
E-mail address: wupeiLin@sdu.edu.cn
form of the Shandong Peninsula. It is divided into seventeen prefecture-level cities, including Jinan, Qingdao, Zibo, Zaozhuang, Dongying, Yantai, Weifang, Jining, Tai’an, Weihai, Rizhao, Laiwu, Linyi, Dezhou, Liaocheng, Binzhou and Heze. With a population of over 95 million, Shandong is the third most populous province in China, only next to Guangdong and Henan. In 2010, the nominal GDP of Shandong was US$603 billion, ranking third of all provinces in China. Its GDP per capita reached US$6,300. Shandong Peninsula is the more affluent area of the province, where Qingdao is well-known for its manufacturing industry in China and abroad, and Dongying’s oil fields and petroleum industries form an important part of Shandong’s domestic products.

Although Shandong has maintained rapid growing in social and economic development, it is suffering from ecological disturbance. The contradiction between natural resources supply and demand, excessive exploitation practice and environment problem are increasingly prominent, marked by water resources shortage, high land reclamation ratio, limited forest cover, increasing emissions of major pollutants such as chemical oxygen demand and sulfur dioxide, low level of industrial structure, large proportion of resource-intensive industries, large amount of carbon dioxide emission and so on [1]. On August 29, 2003, the State Environmental Protection Administration of China (SEPA) agreed to take Shandong province as a pilot province of China’s National Ecological Province Construction Program. As a province with large population and booming economy, Shandong should know clearly its status quo and the trend of conservation culture construction for a sustainable future.

Conservation culture, in short, refers to the harmonious development of man and the nature. In common parlance, it means protecting and improving the ecological environment conditions in the process of developing material civilization. In this sense, conservation culture is the aggregate of all the material and spiritual achievement gained by human following the objective rule of harmonious development of human, nature and society. The main goal of conservation culture construction is to achieve a harmonious co-existence, virtuous cycle, all-round development and sustainable prosperity of human and nature, human and human, human and society [2]. So, it reflects the profound consideration of human’s traditional industrial civilization and modernization theory and practice. Currently, the specific problems challenging conservation culture construction is how to change the traditional mode of economic growth to match the local resources, environment and ecological conditions. To evaluate the current conservation culture development level is essential for such populous, economic booming, resource shortage and environment problem puzzled regions as Shandong to upgrade its regional development quality and ultimately achieve sustainability.

2. The index system of conservation culture evaluation

As people pay more attention to ecological environmental issues, more and more scholars and institutions are engaged into the investigation and construction of conservation culture evaluation system. Song Y. (1999) constructed an urban ecosystem assessment model from the aspects of structure, function and coordination, suggested the evaluation method and analyzed the degree of conservation culture in five coastal cities including Shanghai, Guangzhou, Shenzhen, Tianjin and Hong Kong [3]. Wu Q. (2005) designed the index system of Yangzhou which includes social, economic and natural factors based on the expert consultation to evaluate the eco-city’s development ability [4]. Guan Y. (2007) established an index system based on the concept of resource-conserving and environment-friendly society and carried on accessibility analysis from target, system, status, variables and element [5]. In 2008, a study group from Beijing Forestry University established their Eco-Civilization Construction Indices (ECCI) and evaluated the eco-civilization construction levels of thirty-one provinces in China [6].

Regardless of which method is used, quantitative research is needed to measure the conservation culture development. Referring to the results of above study, we manage to establish our conservation
culture index system based on the current situation of Shandong province (Fig. 1). There are several principles when building the index system. First of all, the conservation culture index system should involve a series of factors covering all the fields of economy, society, environment, resource, ecology, and so on; however the quantification of these factors is by no means exhaustive. We have to select representative factors to calculate the index and avoid potential overlap between indices. Secondly, rationality and accuracy are highly required and all the data must come from authoritative sources. The database and indices should have the attribute of availability, measurability, comparability and operability at the same time, in order that the research results can be reliable and accepted easily by decision-making departments. What’s more, all the indices should have certain sensitivity to the changes of time, space, or the structure of the system, and reflect the degree of social effort extent and the trend of sustainable development [7]. The construction of conservation culture is a long process for human to practice, so the indices should have the significance of guidance and existence in the long term.

![Conservation Culture Index System](image)

Based on the Outline of Shandong Ecological Province Construction Plan and the current situation of social and economic development in 17 cities in Shandong, we select 18 indicators closely related to the social economy, resources and environment, ecological construction in Shandong province and construct the conservation culture index system (Fig. 1). Conservation culture index (CCI) has 3 dimensions, including economic and social structure (ESS), resources and environmental function (REF), and coordination degree between man and nature (CDMN). For every dimension, there are a few sub-dimensions. For each sub-dimension, the sub-index is calculated by a few selected corresponding
indicators. As the structure, function and coordination degree of ecological system is composed by many factors and some of the factors are hard to quantify, there inevitably exist some defects in the index system. Nonetheless, all those indicators are carefully chosen and well organized according to Shandong’s condition; and the evaluation system is qualified to meet our requirement. With delving the issue and detailed data available, more indicators can be added and the index system further modified.

3. Data processing and evaluation methodology

3.1 Data processing methodology

Due to various types and sources of the indices, the order of magnitude and dimension are different. First of all, we standardize the indicators with following processes.

The first step is to standardize all the indicators, transforming the actual value of each indicator into standardized value which falls between 0 and 1. Each indicator can be either positive or negative. The positive indicators are standardized as formula (1), while the negative ones as formula (2):

\[ Q_i = \frac{X_i - \min(X_i)}{\max(X_i) - \min(X_i)} \]  
\[ (1) \]

\[ Q_i = \frac{\max(X_i) - X_i}{\max(X_i) - \min(X_i)} \]  
\[ (2) \]

Where, \( Q_i \) is the standardized value of the indicator \( i \); \( X_i \) is the status value; \( \min(X_i) \) is the minimum value among the related indicators, while \( \max(X_i) \) is the maximum.

Step 2 is to calculate the sub-dimension index. The 18 indicators are divided into 6 sub-dimensions whose values are based on the arithmetic mean value of the standardized values of corresponding indicators. Formula (3) is introduces for the calculation in this step.

\[ V_i = \frac{\sum_{i=1}^{m} Q_i}{m} \]  
\[ (3) \]

Where, \( Q_i \) is the standardized value of related indicators; \( m \) is the number of the indicators included.

Step 3 is to calculate the dimension index. The value of a dimension index is calculated on the weighted average value of sub-dimension index (indices). Formula (4) is used as follows:

\[ Z_i = \sum_{i=1}^{n} W_i V_i \]  
\[ (4) \]

Where, \( W_i \) is the weight of each sub-dimension index \( i \); \( V_i \) is the value of sub-dimension index \( i \); \( n \) is the number of sub-dimensions each dimension consists of.

Step 4 is to aggregate the dimension indices to obtain the conservation culture index. Conservation culture index is based on weighted average value of each dimension index. The value of CCI ranges from 0 to 1. The bigger the value is, the higher the development degree of conservation culture of a place would be. Formula (5) is used to calculate the CCI:

\[ CCI = \sum_{i=1}^{N} U_i Z_i \]  
\[ (5) \]

Where, \( U_i \) is the weight of the dimension index \( i \); \( Z_i \) is the value of dimension index \( i \); \( N \) is the number dimension indices included, 3 in the designed evaluation system.
3.2 Calculation of the weights of indices

The essence of calculating the weight of each index in dimension level or sub-dimension level index level is to assess its contribution to the conservation culture development of the province. The weight should well reflect the rationality of the corresponding indicator(s)’ influence on conservation culture development, in order that the evaluation result is consistent with the reality. Delphi Method is adopted in the paper and the calculation result is as follows (Table 1).

Table 1. Weight of each index level

| Index Level | Index  | Weight | Index  | Weight | Index  | Weight |
|-------------|--------|--------|--------|--------|--------|--------|
| Dimension   | ESS    | 0.372  | REF    | 0.325  | CDMN   | 0.303  |
| Sub-dimension | ED     | 0.512  | RA     | 0.310  | SUD    | 1      |
| Sub-dimension | SOD    | 0.488  | EQ     | 0.330  |        |        |
| Sub-dimension | EP     | 0.360  |        |        |        |        |

3.3 Grading the conservation culture index

According to the above steps, each city’s conservation culture index is achievable. By grading and classifying the indices, we can further determine the degree of conservation culture development in different cities. Referring to some domestic and overseas index grouping methods and Song Y. C. (1999)’s classification table of conservation culture degree, we develop 5 demarcation lines to interpret the conservation culture development among cities in Shandong province as follows (Table 2).

Table 2. Conservation culture index demarcations

| Classification | Value of CCI | Conservation culture development level |
|---------------|-------------|----------------------------------------|
| I             | >0.75       | Very High                              |
| II            | 0.60–0.75   | High                                  |
| III           | 0.50–0.60   | Medium                                |
| IV            | 0.25–0.50   | Low                                   |
| V             | <0.25       | Very Low                               |

4. The evaluation result of conservation culture development of Shandong province

Using selected data from Shandong Statistical Yearbook 2010 and other authoritative sources, we have calculated all the conservation culture indices of the 17 cities in Shandong with the above evaluation methodology. By grading and classifying the CCIs, the 17 Shandong cities can be divided into four types with regard to conservation culture construction (Table 3). CCI of Weihai is the highest, showing a well-developed level of conservation culture. CCI of Dongying, Qingdao, Linyi, and Yantai ranks the second class, whose values are between 0.60 and 0.75, presenting the conservation culture development just next to Weihai. The values of CCI in Weifang, Rizhao, Zibo, Jinan, Binzhou, and Tai’an are between 0.50 and 0.60, implying medium-developed conservation culture there. While in Laiwu, Dezhou, Liaocheng, Jining, Zaozhuang and Heze, the CCIs change from 0.25 to 0.50, indicating a less-developed degree of conservation culture in these cities. Cities with smaller conservation culture indices mean that they are the
less developed cities in conservation culture development. There is no city with CCI below 0.25, or with least developed conservation culture.

Weihai is the only city with CCI exceeding 0.75. It is the most livable city in Shandong or even in China. The three dimension indices of structure, function and coordination are all in high level. In recent years, Weihai has made great efforts to improve ecological and environmental condition. In 2008, Rongcheng, a county-level city in Weihai, was named national eco-city by Ministry of Environmental Protection and it is the first country-level city who obtained this title. It’s obvious that Weihai has made great achievements in the conservation culture construction.

Table 3. Calculated results of Conservation Cultural Indices in Shandong cities

| City      | CCI | Ranking | Dimension | Sub-Dimension |
|-----------|-----|---------|-----------|---------------|
|           |     |         | ESS       | REF | CDMN | ED | SOD | RA | EQ | EP | SUD |
| Weihai    | 0.76| 1       | 0.60      | 0.74 | 0.97 | 0.62 | 0.58 | 0.54 | 0.95 | 0.72 | 0.97 |
| Dongying  | 0.69| 2       | 0.61      | 0.59 | 0.90 | 0.6  | 0.62 | 0.64 | 0.39 | 0.74 | 0.9  |
| Qingdao   | 0.67| 3       | 0.52      | 0.55 | 0.98 | 0.76 | 0.27 | 0.1  | 0.75 | 0.76 | 0.98 |
| Linyi     | 0.64| 4       | 0.44      | 0.75 | 0.79 | 0.29 | 0.59 | 0.76 | 0.7  | 0.78 | 0.79 |
| Yantai    | 0.62| 5       | 0.40      | 0.56 | 0.97 | 0.5  | 0.29 | 0.46 | 0.74 | 0.49 | 0.97 |
| Weifang   | 0.56| 6       | 0.40      | 0.52 | 0.81 | 0.37 | 0.44 | 0.35 | 0.61 | 0.58 | 0.81 |
| Rizhao    | 0.55| 7       | 0.40      | 0.63 | 0.66 | 0.35 | 0.45 | 0.53 | 0.74 | 0.62 | 0.66 |
| Zibo      | 0.55| 8       | 0.43      | 0.54 | 0.71 | 0.59 | 0.26 | 0.23 | 0.63 | 0.73 | 0.71 |
| Jinan     | 0.54| 9       | 0.41      | 0.34 | 0.90 | 0.8  | 0.01 | 0.3  | 0.3  | 0.42 | 0.9  |
| Binzhou   | 0.51| 10      | 0.37      | 0.50 | 0.68 | 0.28 | 0.47 | 0.79 | 0.15 | 0.58 | 0.68 |
| Tai’an    | 0.50| 11      | 0.31      | 0.48 | 0.77 | 0.39 | 0.22 | 0.28 | 0.45 | 0.69 | 0.77 |
| Laiwu     | 0.47| 12      | 0.46      | 0.69 | 0.25 | 0.39 | 0.53 | 0.45 | 0.68 | 0.9  | 0.25 |
| Dezhou    | 0.47| 13      | 0.30      | 0.57 | 0.57 | 0.24 | 0.37 | 0.82 | 0.37 | 0.53 | 0.57 |
| Liaocheng | 0.46| 14      | 0.24      | 0.58 | 0.60 | 0.14 | 0.34 | 0.55 | 0.67 | 0.51 | 0.6  |
| Jining    | 0.43| 15      | 0.28      | 0.38 | 0.68 | 0.3  | 0.26 | 0.39 | 0.5  | 0.27 | 0.68 |
| Zaozhuang | 0.43| 16      | 0.27      | 0.37 | 0.69 | 0.32 | 0.21 | 0.37 | 0.39 | 0.35 | 0.69 |
| Heze      | 0.42| 17      | 0.26      | 0.54 | 0.48 | 0.06 | 0.47 | 0.59 | 0.36 | 0.67 | 0.48 |

Data source: Shandong Statistical Bureau. Shandong Statistical Yearbook 2010.

The indices of Dongying, Qingdao, Linyi, and Yantai belong to level II. A large part of Dongying’s economy revolves around petroleum industry. The growing manufacturing sector and large oil reserves of Dongying have contributed to the city’s high level of economic and social development. However its ecology quality has been negatively influenced by the petroleum industry to some extent. As the leading city in Shandong, Qingdao has higher structure and coordination indices, showing its ecological and economic development superiority in Shandong. But, on the index of resource allocation, and indices of water resources per capita and arable land area per capita, Qingdao lost its advantage.

Weifang, Rizhao, Zibo, Jinan, Binzhou, and Tai’an have a medium index of CCI and belong to level III. On account of large heavy industry proportion in local economy and growing industrial pollution, Zibo paid a big price on both its environment protection and economic growth in the past decades. It ranks second in economic development, but still has room for improving comprehensive utilization ratio of wastes. Jinan is the capital of Shandong. As a political and economic centre, it has highest indices of
service industry, large proportion of tertiary industry, rational industrial structure and high urbanization level. However, as to environmental protection and sustainable development, Jinan has hard work to do.

Indices of Laiwu, Dezhou, Liaocheng, Jining, Zaozhuang and Heze are low and they belong to level IV. Laiwu is a “steel” city with iron and steel enterprises as its backbone industry. Its index of economic and social structure is the highest among the six cities. Being energy-intensive and high-polluting, steel industry has caused certain environmental problems to atmosphere and water resources, which is embodied by its low sustainable development index. So, Laiwu should put more emphasis on conserving energy and reducing emissions of pollutants.

Apparently, the evaluation results by the conservation culture index system are very much in line with the actual situation of conservation culture development in Shandong province. The conservation culture index system we established and the evaluation methodology for conservation culture development are feasible.

5. **Suggestions to improve conservation culture development in Shandong province**

According to the current situation of conservation culture construction in Shandong province, we suggest following strategies to improve the conservation culture development.

First of all, Shandong should accelerate its economic development by strengthening the secondary industry. Shandong is one of the top manufacturing provinces in China now. Regarding the conservation culture development, priorities should be given to high-tech industries, resources saving and environment friendly enterprises. Shandong peninsula is rich in marine resources for marine industry development. Currently, Shandong government is planning to build **Shandong Peninsula Blue Economic Zone** to promote its future regional development. It is a great chance for Shandong to progress its marine industry and marine economy, achieving a leading province in marine products manufacturing and marine science and technology research and development.

Secondly, Shandong should make great efforts to develop circular economy in order to reduce the negative influence on nature resources and environment arising from economic growth. There currently exist serious ecological problems in some cities of Shandong such as water scarcity, farmland shrinking, water and air pollution, which exert stresses on the ecological environment, constrain the local economic growth and affect public health and welfare. Promoting circular economy development should become the obligation and conscious practice of the whole province. It is urgent to improve water resources management and cultivated land protection by efficient legal practices and effective policy reform, to accelerate clean and renewable energy resources utilization to reduce emissions of atmospheric pollutants. Construction of circular economy industrial chain or circular economy industrial park may be effective ways for Shandong to guarantee both economic growth and environment rehabilitation.

Last but not the least, Shandong should coordinate the social and economic development between cities to harmonize its regional development. Each city should rationally make use of its own geographical advantage, natural resources and economic foundation to develop conservation culture from the aspects of economic and social structure, resources and environmental function, and coordination degree between man and nature. Backward cities should learn experiences from advanced cities in economic growth, social progress and ecological protection in order to speed up the pace of conservation culture development.
Acknowledgements

Financial Supports from National Natural Science Foundation of China (No. 40971112) and Chinese Ministry of Education’s Humanities and Social Sciences Planning Project (No. 10YJAZH088) are highly appreciated. The helpful comments of paper reviewers from ISEIS 2011 are also gratefully acknowledged.

References

[1] Che CB. Practice of conservation culture construction. Beijing: China Environmental Science Press; 2009(in Chinese).
[2] Brown LR. Eco-Economy: Building an Economy for the Earth. W. W. Norton & Company; 2001.
[3] Song YC, Qi RH, You WH, Wang XR, Zhu LB. A study on indices system and assessment criterion of eco-city. Urban Environment & Urban Ecology; 1999, 12(05), p. 16-9(in Chinese).
[4] Wu Q, Wang RS, Li HQ, Xu XB. The indices and the evaluation method of eco-city. Acta Ecologica Sinica; 2005, 25(08), p. 2090-5(in Chinese).
[5] Guan YZ, Zheng JH, Zhuang SJ. Study on the index system about ecological civilization. China Development; 2007, 7(2), p. 21-7 (in Chinese).
[6] Yan G, Lin Z, Yang ZH. Assessment of provinces’ conservation culture development in China in 2009. Beijing: Social Sciences Academic Press; 2010, 9(1), p. 1-5 (in Chinese).
[7] Jiang XP. Research on construction of evaluation index system of ecological civilization in Henan province. J Henan Agricultural University; 2008, 42(01), p. 61-4(in Chinese).