DOI:10.16262/j.cnki.1005-0841.2005.02.027

Study on Sustainable Development Capability of Shandong Province

Ren Ziping Luo Qishan Wang Yanchun Deng Hongbing Zhao Jingzhu

(Research Center for Eco-Environmental Sciences, CAS, Beijing 100085)

Based on the indicator system of Sustainable Development (SD), Shandong Province was selected as an example for assessment with AHP method and the standard year was 1978. The conclusion was that Shandong Province's ability of SD was being strengthened step by step, and there were also some restrictive factors, and according to the basic conditions of Shandong Province, countermeasures and strategy of SD were put forward.

Key words sustainable development, assessment, Shandong Province

1 Introduction

With the rapid development of society and economy and the increasing negative influence of human activities on environment, the burden on environment has become heavier and heavier, and the quality of environment has decreased seriously. The sustainable development for human being has been a critically important problem. In this situation, WCED (World Commission on Environment and Development) delivered Our Common Future in 1987, and the concept of sustainable development (SD) was put forward for the first time, that is, Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their needs. In 1992, the concept of SD was emphasized again on the UN conference on Environment and Development (Earth Summit) and many nations including China have promised to bring SD into effect. SD is the development strategy step into a new period, and it is essential to establish on a bearable exploitation base a development model in which economy development, society development and resources, environment protection can harmonize with each other. The core of implementing SD is to realize the harmonious development of economy, society, human and environment[1-3].

To build up SD, capability is the necessary guarantee for stimulating SD actualization. Evaluating a national or regional SD capability is the foundation and important precondition of implementing SD[4-5]. Shandong Province, one of the main coastal Provinces, lies in the east of China and lower reaches of Huanghe. In resent years, GDP of Shandong Province has been increased greatly. However, restrictive factors to its SD have also become visible gradually, some problems and difficulties exist in the development of economy and society. As a result, it is necessary to evaluate SD capability of Shandong Province, using an appropriate assessment indicators system[6-12] and combining with local situations[13-18]. By this means, we can find these existing restrictive factors in the process of SD and frame corresponding countermeasures.

2 Research Methods and Database

2.1 Methods

Analytic Hierarchy Process (AHP) is a decision method, using qualitative analysis and quantitative analysis, based on hierarchies of goals, rules and schemes into which relevant factors are disassembled. Its characteristic is to provide handy decision method for solving multi-goals, multi-rules or non-construction complex decision problems, utilizing less quantitative information coming from the deep analysis of the core, influent factors and their inner-relationship of complex decision problems.

AHP is applicable to ascertaining comprehensive weights of multi-construction assessment index system. In the process of assessing sustainability, AHP is not only used to analyze and make sequencing of multi-hierarchies influencing SD process, but to analyze the complicated SD system as well.

The primary steps of AHP are as the following:

(1) Confirm the goal after deeply analyzing the entire system.

(2) Classify the system according to different goals or functions.

(3) Develop a multi-layer structure.

(4) Determine the relevant weights of neighboring factors in the multi-layer structure. This is to determine the relative weight or synthetic weight to an upper-layer factor or other relevant factors on the same layer by judgment matrix and matrix operation.

(5) Calculate and sequence synthetic weights of each factor to the system goal, determine the important extent to the system goal of factors on the lowest layer in the multi-layer structure.

(6) Analyze the assessment result according to the relative weights, and put forward corresponding decisions.

2.2 Data resources

The data used in this paper come from China Statistical Yearbook, Shandong Statistical Yearbook, China Environmental Statistical Yearbook, China Statistical Yearbook on Science and Technology, China Water Resource Yearbook, and part of Shandong Yearbook and Shandong Water Resource Yearbook.

The sustainability assessment index system of Shandong is composed of 5 parts. They are Economy, Society Development, Human and Cultural, Resources and Environment and each of them contains 1—6 variables. The selected years for assessment are 1978, 1985, 1990, 1995, 2000 and 2002.

3 Assessment Index System and Analysis

We show the sustainability assessment index system by Table 1 and the weighs for the 5 parts are expressed in Table 2. We have also calculated the weights of variables contained by each of the 5 parts. The main results are shown in Table 3—7.

Table 1 Sustainability assessment index system of Shandong Province (1978 as benchmark)

Indicator	Year					
	1978	1985	1990	1995	2000	2002
Economy indicator(B_1)						
GDP/Capita (C_1)	100.00	280.70	574.37	1822.15	3023.73	3685.13
Grain yield/Capita (C_2)	100.00	127.34	131.54	152.61	133.49	113.46
Transit length/Capita (C_3)	100.00	98.69	101.22	129.85	163.73	169.67
Investment in fixed assets/Capita (C_4)	100.00	430.94	675.82	2594.88	4832.61	6607.40
Government revenue as percentage to GDP (C_5)	100.00	34.90	25.39	12.58	19.09	20.33
Society development indicator(B_2)						
Population density* (C_6)	100.00	107.66	118.60	121.66	125.60	126.91
Employment (%)(C_7)	100.00	119.90	136.14	175.36	183.24	186.10
Consumption/Capita (C_8)	100.00	229.59	413.02	1149.70	2051.48	2338.46
Expenditure for science, education, public health and culture/GDP (C_9)	100.00	89.90	85.63	60.73	71.69	79.23
Number of important achievements in S&T (C_{10})	100.00	183.44	323.93	498.62	571.78	462.88
Human and Cultural indicator(B_3)						
University and college students per 10,000 population (C_{11})	100.00	202.24	237.13	352.43	630.04	1198.88
Doctors or medical technical persons per 10,000(C_{12})	100.00	126.89	135.42	148.29	166.87	164.07
Resources indicator(B_4)						
Cultivated land/Capita (C_{13})			100.00	96.47	92.24	100.95
Energy production/Capita (C_{14})	100.00	119.12	133.00	150.77	130.90	178.03
Forests cover (C_{15})			100.00	117.65	104.71	110.59
Environment indicator(B_5)						
Industrial waste water in land area* (C_{16})		77.16	100.00	116.19	69.53	96.69
Industrial waste gas in land area* (C_{17})		64.20	100.00	137.26	132.73	117.46
Industrial solid waste in land area* (C_{18})		70.82	100.00	115.56	120.59	121.29
Rate of industrial waste water up to discharge standard (C_{19})		125.59	100.00	111.65	325.41	103.49
Rate of industrial solid wastes utilized in a comprehensive way (%)(C_{20})		80.79	100.00	187.63	119.37	112.69
Public green area/Capita, urban (C_{21})			100.00	128.21	206.67	249.74

Indicators with * are adverse indicators which means that the higher numerical values they are, the worse the condition is.

Table 2 Weights of the 5 index layers

A	B_1	B_2	B_3	B_4	B_5	Sum of the same row	Relative weight
B_1	1	1	5	3	3	13	0.3344
B_2	1	1	5	3	3	13	0.3344
B_3	1/5	1/5	1	1/3	1/3	1.53	0.0394
B_4	1/3	1/3	3	1	1	5.67	0.1459
B_5	1/3	1/3	3	1	1	5.67	0.1459

Table 3 Relative weights of indicators in economy layer

B_1	C_1	C_2	C_3	C_4	C_5	Sum of the same row	Relative weight
C_1	1	3	5	5	5	19	0.4760
C_2	1/3	1	3	3	3	10.33	0.2588
C_3	1/5	1/3	1	1	1	3.53	0.0884
C_4	1/5	1/3	1	1	1	3.53	0.0884
C_5	1/5	1/3	1	1	1	3.53	0.0884

Table 4 Relative weights of indicators in society development layer

B_2	C_6	C_7	C_8	C_9	C_{10}	Sum of the same row	Relative weight
C_6	1	5	3	3	3	15	0.4145
C_7	1/5	1	1/3	1/3	1/3	2.2	0.0608
C_8	1/3	3	1	1	1	6.33	0.1749
C_9	1/3	3	1	1	1	6.33	0.1749
C_{10}	1/3	3	1	1	1	6.33	0.1749

Table 5 Relative weights of indicators in human & culture development layer

B_3	C_{11}	C_{12}	Sum of the same row	Relative weight
C_{11}	1	1	2	0.5
C_{12}	1	1	2	0.5

Table 6 Relative weights of indicators in resources layer

B_4	C_{13}	C_{14}	C_{15}	Sum of the same row	Relative weight
C_{13}	1	1/5	3	4.2	0.2824
C_{14}	5	1	3	9	0.6052
C_{15}	1/3	1/3	1	1.67	0.1124

Table 7 Relative weights of indicators in environment layer

B_5	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	Sum of the same row	Relative weight
C_{16}	1	1	1	3	3	5	14	0.2506
C_{17}	1	1	1	3	3	5	14	0.2506
C_{18}	1	1	1	3	3	5	14	0.2506
C_{19}	1/3	1/3	1/3	1	1	3	6	0.1074
C_{20}	1/3	1/3	1/3	1	1	3	6	0.1074
C_{21}	1/5	1/5	1/5	1/3	1/3	1	1.87	0.0334

Considering these relative data of Shandong Province, we chose Year 1978 as benchmark year and the value of the data of Year 1978 was 100. Then, we evaluated all indicators and standardized them (Table1). Third, we multiplied every numerical value by homologous weights and got the weighted sum which we called sustainability (Table 8, Fig. 1). After analyzing carefully, we found that (1) sustainability of Shandong Province grew gradually; (2) during 1978—1990, sustainability grew at a lower rate, while after Year 1990, it grew faster.

Table 8 Development comprehensive index of Shandong Province (1978 as benchmark)

Development comprehensive index	Year					
	1978	1985	1990	1995	2000	2002
(S(t))	51.94	106.35	180.10	494.17	812.61	994.96

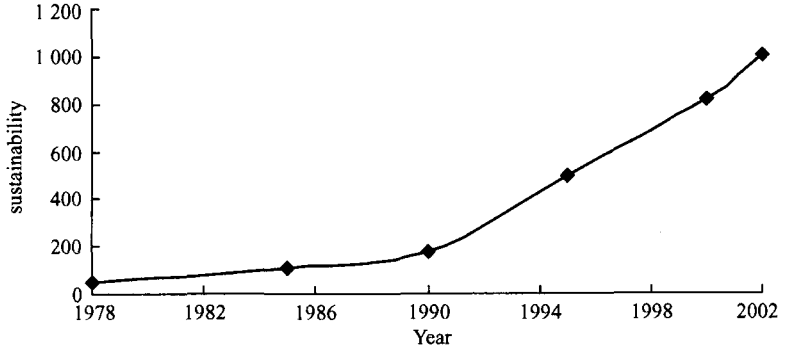

Fig. 1 Change of sustainability of Shandong Province

4 Discussion about Limiting Factor to Sustainability of Shandong Province

4.1 Population pressure

Shandong Province has a large population; its population in 1998 reached 88.38 million and ranked 2nd in China. Shandong is now struggling in the conflict between low growth rate and high quantity growth and will be having a long-term population increase. Beside these unsolved problems, Shandong is now encountered with tough challenges, such as aging population, great pressure of employment, and a sound social security system in urgent need. These problems mentioned above are the pivotal factors restricting sustainability of Shandong Province.

4.2 Resources in shortage

Relative shortage, lower utilization, serious waste and breakage have forced natural resources of Shandong Province into corner, and these problems are not yet solved entirely. In Shandong Province, land resources are in serious shortage. Land area per capita is only 0.17 ha., and cultivated land per capita is only about 0.085 ha. Less land in reserve and the difficulty for exploitation are hard to surmount. The amount of storage of mineral resources of Shandong Province is at medium level but per capita is much smaller. Part of mineral resources are even at the edge of depletion. Hidden value of mineral resources per capita is less than 0.05 million RMB, only 49% in comparison to the national average. As to water resource, the total amount is 31 billion m^3, 1.1% of the national average; the amount of per capita is 356 m^3, 15.9% of the national level.

4.3 Environmental pollution

The quality of ecological environment of Shandong Province has been improved after several years of treatment. However, there are still some environmental problems, for example, relative large amount of pollution discharged, pollution of system structure, bad quality of urban environment, and frangibility of ecological system. Water loss & soil erosion and water pollution are serious; it is hard to provide enough eco-environmental water and hard to keep water ecological equilibrium. Plant ecosystem restoration is at a low speed, forest-coverage rate is low, soil desertification, ground-water descent and sea-water invasion have become more serious. Cut off of Huanghe has been a vital ecological problem to Shandong Province; there are also many serious problems in marine ecology; natural disasters are happening with increasing frequency, such as drought and waterlog, and sand blown by wind and hailstone. In addition, the devotion to environmental protection is insufficient. During the Ninth Five-year Plan period, investment of environmental protection is 39.7 billion, only 1.1% of GDP of Shandong Province, and is far from the needs of pollution control and ecological protection.

4.4 Support system faultiness

At present, resources & environment bearing capacity does not get enough consideration. Traditional industries with large amount pollution dis-

charged and inputs of resources, such as food processing, testile industry, chemical industry and paper industry, are still preponderating. There are many small township enterprises with lower grade of product level, less production capability and equipment and unsubstantial technical development ability. In a word, "Two highs" (large amount pollution discharged and inputs of resources) and "Two lows" (low labor price and sale price) which are the typical features of traditional economic development model are not changed completely. In Shandong Province, system of policy and statute relating to sustainable development is not perfect, while present policies and rules of law are not suitable for principles of sustainable development.

5 Conclusions

As a big economic province, Shandong Province must institute and implement sustainable development (SD) strategy incorporating actual conditions in order to achieve economy and society development goals. The emphasis of implementing SD strategy is to settle restricting key-factors; that is to effectively popularize cleaner produce, to accelerate conversion of economic development model into lower consumption, less pollution and high efficiency; to powerfully control population increase, promote population quality and solve the problem of ageing population; to mend and establish employment and social security system; to effectively lighten the restricting effects of water resource from water conservancy and saving; to scientifically and reasonably use natural resources and build abstemious resources type of economy development mechanism; to set down and implement ecological environment protection measures, to fulfill policies of pollution treatment connecting with ecological protection.

First, effectively implement SD strategy. Local government should regard SD strategy as a long-term primary strategy, arrange every piece of work from the point of harmonious development, and establish a comprehensive decision mechanism to favor the harmonious development of environment, economy and society; should make effectively implementing SD strategy as a part of main schedule and supervising scope; should establish effective goal-responsibility mechanism.

Second, bring SD index system into medium to long term plan of national and social development. This is a key step for implementing SD strategy. Local government should set up a SD national economy evaluation system.

Third, accelerate consummate rule and regulation system in order to legalize implementing SD strategy. Local government of Shandong Province has gradually strengthened legislation connected with SD and citizen's legal consciousness has been enhanced. However, compared with the need of implementing SD strategy, there is still much formidable work in legal system.

Forth, emphasize perfecting SD economic policy and establishing money raising mechanism. Current industrial policy, financial policy, price policy and trade policy need to be evaluated against SD adaptability, to be edited or abolished. To gradually establish SD money raising mechanism with enough amount and intention of investment and high effective managing and running system.

Fifth, establish SD managing harmonious mechanism. To establish goal-responsibility mechanism for SD, to perfect organization and management system for SD, to enhance controlling and managing function of government, to perfect SD supervising and evaluating system, to set up timely promulgating system of SD situation.

Sixth, implement the strategy of invigorating Shandong Province through science and education and advance the support ability of science and education. In order to set up SD frame suitable for Shandong Province, we need to advance gradually the support ability of science and education and institute relative policy, rules and laws.

Seventh, accelerate opening up strategy, boost international cooperation and communication in the field of SD.

Eighth, enhance SD consciousness and promote citizen's participation ability.

References

[1] Adriaanse A. Environmental policy performance indicators. The Hague: Ministry of Housing, Physical Planning and the Environment, 1993.

[2] Amsberg J V. Project evaluation and the depletion of natural capital. World Bank: Environmental working Paper, 1993, No. 56.

[3] Zhao J Z. Macro policy analysis of China sustainable development. Science Guide, 1998, 13(12): 51—54.

[4] Zhao I Z, Liang X Y, Zhang X D. System analysis on the definition of sustainable development. Acta Ecologica Sinica, 1999, 19(3):393—398.
[5] Li J H. System of sustainable development appraisal in China. Beijing: Social Science Literature Press, 2000.
[6] Hao X H. Study on sustainable development indicators. World Environment, 1996, (1): 11—13.
[7] Bossel H. Indicators for sustainable development: theory, method, application. A Report to the Balaton Group. Winnipeg: International Institute for Sustainable Development, 1999.
[8] Zhao J Z, Wu W. Indicators and synthetic evaluation of sustainable development. National Natural Science Foundation of China, 1995, 5(4): 39—42.
[9] Mao H Y. Study on sustainable development indicators of Shandong province. Geology Research, 1996, 15(4): 16—23.
[10] Li L H. Sustainable development indicators and evaluation methods of Guangdong province. Sichuan: South-western Business University Press, 2002.
[11] Qin Y et al. Study on sustainable development indicators of Liaoning province. China Soft Science, 1997, (11): 17—21.
[12] Dong Z H. The guidebook of sustainable development for Shandong province candres. Beijing: Scientific Press, 2000.
[13] Editorial Board of Shandong Local History. Shandong yearbook 1990—2003. Beijing: Word Knowledge Press, 1990—2003.
[14] Government of Shandong Province, Editorial Board of Shandong Local History. Information and Database Net of Shandong Province: http://www.infobase.gov.cn/
[15] Statistics Bureau of Shandong Province. Shandong statistics yearbook 1989—2003. Beijing: China Statistics Press, 1989—2003..
[16] Ministry of Water Resources. Yearbook of China water resources 1990—2003. Beijing: China Water Resource and Electricity Press, 1990—2003.
[17] National Statistics Bureau. Statistics yearbook of China 1987—2003. Beijing: China Statistics Press, 1987—2003.
[18] Research Group of China Sustainable Development, Chinese Academy of Sciences. Strategy report of China sustainable development 1999—2004. Beijing: Scientific Press, 1999—2004.

Vice President Zhu Daoben Attended the Second China-US Conference

On Nov. 15, 2005, the Second China-US Conference was held at Kunlun Hotel, Beijing. Prof. Zhu Daoben, Vice President of NSFC attended the meeting and made remarks at the S&T session.

The conference is hosted by the Chinese People's Association for Friendship with Foreign Countries, Texas A&M University, George Bush Presidential Library Foundation and the George Bush School of Government and Public Service. Important guests from governments, academia and industry of China and the US attended the conference.

(Liu Xiuping)