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Analysis on the difference of sustainable development ability and influencing factors of four types of Resource-based Cities

--Take Zhongyuan economic zone as an example

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Abstract

With the gradual depletion of resources, the state attaches great importance to enhancing the sustainable development capacity of resource-based cities. Therefore, this paper constructs the comprehensive evaluation index of sustainable development of resource-based cities, and quantifies the sustainable development ability by using entropy weight method and grey comprehensive evaluation method. Taking the data of 40 resource-based cities in 5 provinces around Zhongyuan economic zone as an example, this paper makes a time longitudinal analysis on the sustainable development ability of each city, and discusses the influencing factors of the sustainable development of four types of resource-based cities. The results show that: ① since 2013, the sustainable development ability of most resource-based cities has been enhanced, a few cities have shown negative growth, and the growth rate varies greatly among different cities. ② On the whole, scientific and technological innovation has the greatest impact on the sustainable development of resource-based cities and the least impact on survival support. The impact of economic development, people's livelihood improvement and ecological environment protection on sustainable development appears differentiation in the four types of cities.

Keywords

Resource-based Cities, Sustainable development Entropy weight method, Grey comprehensive evaluation, Influence factor.

1. Introduction

Resource-based city is a city that takes the natural resources exploitation and processing as the leading industry in the region, and is the national resource and energy strategic guarantee base[1]. In China, resource-based cities are the decisive factor supporting the long-term, stable and rapid development of the national economy. However, with the emergence of the resource curse, such as insufficient resources, deteriorating ecological environment and unbalanced industrial structure, it is imminent to enhance the sustainability of resource city development. In November 2013, the State Council officially issued The National Sustainable Development Plan for Resource-based Cities (2013-2020). The document divides resource-based cities into four types: growth, maturity, decline and regeneration, lists the main indicators of sustainable development of resource-based cities, and clearly points out in the goal that by 2020： The problems left over by the history of resource exhausted cities have been basically solved, and the ability of sustainable development has been significantly enhanced [2]. With the severity of practical problems and the deepening demand for policy reference, scholars from all walks of life have also studied the sustainable development of resource-based cities from different angles.

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One is the research on the methods and Countermeasures for the sustainable development of Resource-based Cities: Zhang Maosheng [3] and Zhang Maozhong puted forward eight countermeasures to enhance the sustainable development ability of exhausted industrial and mining cities, such as cultivating alternative industries, strengthening urban functions and strengthening interregional ties; Xie Jingwu [4] suggested innovating the resource development mechanism, strengthening the management of the ecological environment, policy assistance and industrial transformation to solve the "three dangers" of resource-based cities; Wang Shuyi [5] and Guo Shaoqing puted forward the Sustainable Development Countermeasures of resource exhausted cities from two aspects: policy support and legislative guarantee; Yue Liping [6] established a long-term mechanism for the sustainable development of resource-based cities from the perspective of subject heterogeneity, spatial heterogeneity and type heterogeneity. After a long time of exploration and practice, this kind of research has gradually matured and formed a mechanism.

The other is the research on the evaluation of the sustainable development ability of Resource-based Cities: Li Jing [7] explored the evaluation index system from the four aspects of economy, society, environment and resources; Dai Sijun [8] and Dong Dianwen defined the sustainable development capacity of resource-based cities from three dimensions: economic management, government social management and resource management. At the same time, most scholars focus on the comprehensive evaluation method of sustainable development ability combined with empirical research. Zhu Mingfeng [9] and Hong Tianqiu established the sustainable development index system of resource-based cities based on neural network to study a resource-based city; Xi Qingmei [10], Zhang Qin [11] and Li Xiaochun evaluated the sustainable development capacity of Pingdingshan City and Ordos City respectively by means of subjective weighting of analytic hierarchy process and linear weighted summation method; Fu Guijun [12] and Qi Yijun used the fuzzy comprehensive evaluation method to measure the sustainable development ability of Shanxi and Inner Mongolia; Guo Shufen [13] and Ma Yuhong made a time vertical comparative analysis on the sustainable development capacity of Shanxi Province by using the comprehensive graphic method of fully arranged polygons and the calculation method of distance coordination degree.

Through literature review, it is found that the research on the evaluation of sustainable development capacity of resource-based cities mostly focuses on the innovation of evaluation indicators or evaluation methods, and then carries out empirical research combined with specific cities or provinces, and there is less analysis of the differences between different types of resource cities. Therefore, on the basis of previous achievements, combined with the sustainable development indicators and comprehensive classification of resource-based cities in The National Sustainable Development Plan for Resource-based Cities (2013-2020)., this paper takes 40 resource-based cities in the five provinces around the Central Plains Economic Zone as the research object, uses the grey comprehensive evaluation method to quantify the sustainable development capacity as the correlation evaluation index, and expresses the influence degree by the contribution rate of each index, It is expected that through research, while clarifying the changes of sustainable development capacity of resource-based cities in the Central Plains Economic Zone, it also explores the differences of sustainable development capacity and influencing factors among different types of resource cities, so as to provide some reference for accelerating the coordinated development of the Central Plains Economic Zone.

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2. Evaluation index system of sustainable development capacity of Resource-based Cities

2.1. Indicator determination principle

The selected indicators can accurately and truly reflect the sustainable development level of resource-based cities, and can reflect the characteristics of resource-based cities different from general cities in the specific content of indicators. At the same time, the meaning of indicators should be clear, the measurement methods should be standard, and the statistical methods should be standardized.

The sustainable development ability of resource-based cities is the result of the comprehensive influence of many factors. When establishing the index system, we should reflect the correlation between various factors and refine the sustainable development evaluation system layer by layer.

The availability and reliability of data should be taken into account when selecting indicators, so as to ensure the feasibility of comprehensive evaluation.

2.2. Page Numbers

This paper is based on the four main indicators of sustainable development of national resource-based cities listed in The National Sustainable Development Plan for Resource-based Cities (2013-2020): economic development, improvement of people's livelihood, resource guarantee and ecological environment protection (among which resource guarantee is a national comprehensive index and can not be applied to the evaluation of specific resource-based cities); At the same time, the survival support system and scientific and technological intelligence support system in 2013 China's Sustainable Development Strategy Report - the Road of Ecological Civilization in the Next 10 Years and Research on the Sustainable Development of China's Resource-based Cities are used for reference [14-15].This paper constructs the evaluation index system of sustainable development ability of resource-based cities from five aspects: economic development, improvement of people's livelihood, ecological environment protection, survival support and scientific and technological innovation. The five primary indicators are subdivided into 34 measurement indicators, as shown in Table 1.

Table 1: The evaluation index system of sustainable development ability of resource-based cities

Primary index	Secondary index	Measure index	Attribute
Economic development X1	Economic level X11	Per capita GDP X111	+
		Growth rate of regional GDP X112	+
		Proportion of fixed asset investment in regional GDP X113	+
		Growth rate of gross output value of industries above Designated Size X114	+
	Economic structure X12	Proportion of tertiary industry in regional GDP X121	+
		Proportion of employees in tertiary industry in total employees X122	+
Improvement of people's livelihood X2	living standard X21	Per capita disposable income of urban residents X211	+
		Per capita net income of rural residents X212	+
	Social stability X22 *X* 22	Urbanization rate X221	+
		Registered unemployment rate in cities and townsX222	-
	Infrastructure X23	Number of buses per 10000 people X231	+

		Number of beds in hospitals and health centers per 10000 people X232	+
	Social security X24	Participation rate of basic medical insurance for urban employees X241	+
		Participation rate of basic endowment insurance for urban employees X242	+
Ecological environment protection X3	Environmental pollution X31	Per capita industrial wastewater discharge X311	–
		Per capita industrial sulfur dioxide emission X312	–
		Per capita industrial smoke emission X313	–
	Environmental governance X32	Centralized treatment rate of sewage treatment plant X321	+
		Comprehensive utilization rate of general industrial solid waste X322	+
		Greening coverage rate of built-up area X323	+
	Environmental benefits	Average energy consumption per 10000 yuan of GDP X331	+
Survival support X4	Land endowment X41	Per capita sown area of crops X411	+
		Proportion of urban construction land in urban area X412	+
	Agricultural endowment X42	Per capita grain output X421	+
		Per capita gross output value of agriculture, forestry, animal husbandry, sideline Fisheries X422	+
	Population endowment X43	Natural population growth rate X431	+
		Population density X432	–
Technological innovation X5	Basic environment X51	Number of teachers in Colleges and universities per 10000 people X511	+
		Number of students in ordinary colleges and universities per 10000 people X512	+
		Number of books in public libraries per 100 people X513	+
	Financial input X52	Proportion of education expenditure in general public financial expenditure X521	+
		Proportion of science and technology expenditure in general public financial expenditure X522	+
	Network information Popularization X53	Internet broadband penetration X531	+
		Mobile phone penetration X532	+

Economic development indicators are mainly used to reflect the current economic sustainability of resource-based cities. Due to the particularity of the industrial life cycle of resource-based cities, we should pay attention to the transformation of the industrial structure of resource-based cities in order to reflect the sustainability of their leading industries; Secondly, it is also necessary to evaluate the current economic development level supporting the future sustainable development of the economy. This paper selects four measurement indicators such as per capita regional GDP to reflect the achievements, rate, government support and industrial economic development rate of the current economic development.

Livelihood improvement indicators are mainly used to evaluate the social sustainable development capacity of resource-based cities. The livelihood improvement indicators in The National Sustainable Development Plan for Resource-based Cities (2013-2020) mainly reflect the living standards of the people, but the requirements for sustainable development of the people's livelihood are not only the improvement of people's living standards, but also the synchronous development of the stability of social development, the completeness of infrastructure and the perfection of social security. Therefore, based on the indicators of living standards, this paper expands three secondary indicators: social stability, infrastructure and social security. Each secondary index is measured by two measurement indexes.

Eco environmental protection indicators are mainly used to evaluate the environmental sustainable development capacity of resource-based cities. The plan mainly uses pollutant discharge and energy consumption per unit of GDP to reflect the capacity of ecological environment protection. Environmental pollution exists objectively in resource-based cities, so strengthening environmental governance is an essential link in the pursuit of environmental sustainable development. On the basis of the plan, this paper establishes two secondary indicators of environmental pollution and environmental benefits, appropriately introduces environmental governance as a supplement, and establishes an evaluation system of environmental sustainable development capacity combining pollution, governance and benefits.

Survival support indicators are mainly used to evaluate the ability of resource-based cities to meet the basic needs of people and cities. There are mainly land endowment, agricultural endowment and population endowment to meet the basic survival of the people. Land endowment includes two parts: grain planting land and construction land, which are measured by per capita crop sowing area and the proportion of urban construction land in urban area; Agricultural endowment reflects the basic material output of cities to meet people's living needs. This paper uses two measurement indexes: per capita grain output and total output value of agriculture, forestry, animal husbandry, sideline Fisheries (broad agriculture); Population is the basic element of urban survival and development, which reflects the most basic sustainability of the city. This paper uses two indicators: natural population growth rate and population density to evaluate.

Scientific and technological innovation indicators are mainly used to evaluate the ability of resource-based cities in science and technology investment and innovation environment. Due to the limitation of the life cycle of resource-based industries, to strengthen the sustainable development ability of resource-based cities, it is inevitable to adjust the industry, increase scientific and technological investment, cultivate emerging industries and change the inefficient mode of production. Therefore, when evaluating the sustainable development capacity of resource-based cities, this paper introduces scientific and technological innovation indicators, which are subdivided into three secondary indicators: basic environment, financial investment and network information popularization, and evaluated with seven measurement indicators.

3. Summary of study area and research methods

3.1. Study area

Located in the center of China, the Central Plains Economic Zone is a key development area with clear national main functional zone planning and plays an important strategic role in the overall situation of national reform and development. The region includes Henan Province and some areas of Shanxi, Hebei, Shandong and Anhui. In December 2012, the National Development and Reform Commission in The Central Plains Economic Zone plan (2012-2020) required to adhere to the concept of green and sustainable development, strengthen environmental protection and ecological construction, improve the level of intensive utilization of resources, strive to build a sustainable mode of production and consumption, build an ecological and green Central Plains, and enhance the capacity of regional sustainable development [16]. In view of this, this paper focuses on the Central Plains Economic Zone. While discussing the sustainable development capacity and influencing factors of different types of resource cities, it also defines the changes of the sustainable development capacity of resource-based cities in the Central Plains Economic Zone since the implementation of The Central Plains Economic Zone plan (2012-2020).

Considering the integrity of regional units and the representativeness of quantity, this paper expands the research scope to all regions of five provinces, and selects a total of 40 research objects, including 38 prefecture level resource-based cities and 2 county-level resource-based cities (among the 38 prefecture level resource-based cities, there is only 1 growth resource-based city, and 2 county-level growth resource-based cities are added to enhance the scientificity of classified research), It accounts for nearly 1/3 of 126 prefecture level resource-based cities in China..

3.2. Time period selection and data source

Taking the implementation time of the plan as the dividing point, 2009, 2013 and 2017 are selected as the time windows for empirical analysis. Analyze the sustainable development capacity and growth rate of various types of resource cities. The sustainable development capacity is quantified as the correlation evaluation index, and the sustainable development growth rate is the average annual growth rate of the evaluation index. The calculation formula of average annual growth rate is:

$$v = \left(\frac{R_{a_1}}{R_{a_2}}\right)^{\frac{1}{a_1 - a_2}} - 1$$

(v represents the average annual growth rate; R_a represents the comprehensive evaluation index of the year)

The data in the evaluation system are from China Statistical Yearbook, China Urban Statistical Yearbook, China Regional Economic Statistical Yearbook, and Statistical Bulletins and statistical yearbooks of various provinces and cities in the corresponding years. In order to obtain the measurement index data, this paper looks for 4800 direct data, which inevitably has the phenomenon of partial data missing. It will be estimated by replacing the data in adjacent years or analyzing the development trend. There are 126 such data, accounting for 2.6%.

3.3. Dimensionless data processing

In the evaluation system of sustainable development capacity of resource-based cities constructed in this paper, there are differences in dimensions, contents and attributes of each index. In order to eliminate the impact of different dimensions and attributes among indicators and objectively reflect the real situation of the evaluated object, dimensionless processing will be adopted for the original data [17-18].It is defined that the evaluation index system consists of n measurement indexes and m evaluation objects. x_{ij} represents the original data of the j-th measurement index of the i-th evaluation object, and y_{ij} represents the corresponding dimensionless standard data. （i =1, 2, ⋯, m； j =1, 2, ⋯, n ）

Dimensionless treatment of positive indicators:

$$y_{ij} = \frac{x_{ij} - \min x_j}{\max x_j - \min x_j}$$

Dimensionless treatment of negative indicators:

$$y_{ij} = \frac{\max x_j - x_{ij}}{\max x_j - \min x_j}$$

3.4. Determination of index weight

The entropy weight method objectively weights according to the size of the measured index information entropy. The smaller the information entropy, the more information the index

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contains, and the greater the impact of the index on the comprehensive evaluation, the greater the weight. Therefore, the use of entropy weight method can eliminate the interference of subjective factors as much as possible and make the evaluation results more realistic [19-20].The specific process of empowerment is as follows:

(1) Calculate the information entropy of j-th index:

$$H_j = -\frac{1}{\ln m}\sum_{i=1}^{m} P_{ij}\ln P_{ij}$$

$$P_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}}$$

Determine the weight of the j-th index:

$$W_j = \frac{1-H_j}{\sum_{j=1}^{t}(1-H_j)}$$

According to the actual data of each year, according to the classification of economic development, improvement of people's livelihood, ecological environment protection, survival support and scientific and technological innovation, the entropy weight method is used to calculate the index weight of each year by using Excel.In order to ensure the vertical comparability, the mean value of the three-year weight is taken as the final weight.

3.5. Comprehensive evaluation method

Sustainable development involves population, economy, society, resources, environment, science and technology, and the influencing factors are complex. The indexes in the evaluation system contain a lot of known and unknown information, so it is a grey system. Therefore, based on previous studies, this paper decides to use the grey comprehensive evaluation method to explore the sustainable development capacity of resource-based cities [21].The specific steps are as follows:

The standard data is obtained after dimensionless processing of the original data, and the comparison matrix is established using the standard data, as follows:

$$Y = \left(y_{ij}\right)_{m\times n} = \begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{bmatrix}$$

（i=1, 2, ⋯, m； j=1, 2, ⋯, n）

The best value of each measure index is selected as the original data of the reference sequence, recorded as x_{0j}, and the corresponding standard data y_{0j} is obtained after dimensionless processing. To establish a reference sequence: $Y_0 = \left(y_{01}, y_{02}, \cdots, y_{0n}\right)$

The selection method of the best value of the measurement index is as follows:

$$x_{0j} = \begin{cases} \min x_{ij}, & x_{ij} \text{ is a negative indicator} \\ \max x_{ij}, & x_{ij} \text{ is a positive indicator} \end{cases}$$

Calculate correlation coefficient

$$\xi_{ij} = \frac{\min\limits_{i}\min\limits_{j}\left|y_{0j}-y_{ij}\right| + \rho\max\limits_{i}\max\limits_{j}\left|y_{0j}-y_{ij}\right|}{\left|y_{oj}-y_{ij}\right| + \rho\max\limits_{i}\max\limits_{j}\left|y_{0j}-y_{ij}\right|}$$

(i =1, 2, ⋯, m ; j =1, 2, ⋯, n)

After calculation one by one, the correlation coefficient matrix can be obtained:

$$E = \left(\xi_{ij}\right)_{m\times n} = \begin{bmatrix} \xi_{11} & \xi_{12} & \cdots & \xi_{1n} \\ \xi_{21} & \xi_{22} & \cdots & \xi_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \xi_{m1} & \xi_{m2} & \cdots & \xi_{mn} \end{bmatrix}$$

(i =1, 2, ⋯, m ; j =1, 2, ⋯, n)

Calculate correlation

The weights of each index determined by entropy weight method form a weight matrix as follows:

$$W = \left(w_1, w_2, \cdots w_n\right)$$

Calculate correlation:

$$R = \left(r_i\right)_{1\times m} = \left(r_1, r_2, \cdots, r_m\right) = WE^T$$

The evaluation index system constructed in this paper includes three layers (the secondary index only plays the role of classification and does not participate in the evaluation).Therefore, after the comprehensive evaluation of the most basic indicators, it is necessary to take the evaluation results as the original data of the next level, and repeat the weighting and comprehensive evaluation at a higher level until the correlation degree of the highest level indicators is calculated. This correlation degree value is the sustainable development evaluation index of each resource-based city.

4. Result analysis

4.1. Overall result evaluation

The grey comprehensive evaluation method is used to calculate the sustainable development evaluation index of each city in 2009, 2013 and 2017, and then the average annual growth rate of sustainable development index in 2009-2013 and 2013-2017 is obtained. In order to increase the objectivity and reference of comparison, the provincial average data of Hebei, Shanxi, Shandong, Anhui and Henan and the average value of five provinces are added for analysis. The specific results are shown in Table 2 and table 3.

Table 2: The sustainable development capacity evaluation index of each city in 2013 and 2017

City	Sustainable development capacity evaluation index				Ranking change	City	Sustainable development capacity evaluation index				Ranking change
	2013	Ranking	2017	Ranking			2013 year	Ranking	2017 year	Ranking	
Dongying	0.629	1	0.669	1	0	Chizhou	0.438	10	0.481	21	-11
Jinzhong	0.413	26	0.641	2	24	Zaozhuang	0.408	30	0.477	22	8
Zibo	0.501	4	0.595	3	1	Zhangjiakou	0.422	18	0.474	23	-5
Ma'anshan	0.432	13	0.571	4	9	Hebi	0.421	20	0.473	24	-4
Luoyang	0.431	14	0.555	5	9	Huaibei	0.425	15	0.464	25	-10
Chuzhou	0.477	5	0.549	6	-1	Handan	0.457	8	0.454	26	-18
Nanyang	0.401	34	0.539	7	27	Xingtai	0.422	19	0.448	27	-8
Linyi	0.446	9	0.527	8	1	Huainan	0.407	31	0.448	28	3
Tonglin	0.566	2	0.520	9	-7	Chengde	0.409	29	0.446	29	0
Tai'an	0.460	7	0.518	10	-3	Jincheng	0.416	24	0.442	30	-6

Haozhou	0.462	6	0.516	11	-5	Yongcheng	0.410	28	0.438	31	-3
Xuancheng	0.524	3	0.511	12	-9	Shuozhou	0.407	32	0.429	32	0
Suzhou	0.404	33	0.505	13	20	Yizhou	0.422	17	0.429	33	-16
Puyang	0.438	11	0.504	14	-3	Datong	0.394	36	0.428	34	2
Tangshan	0.419	23	0.503	15	8	Yuncheng	0.420	21	0.425	35	-14
Jining	0.437	12	0.500	16	-4	Changzhi	0.383	39	0.421	36	3
Pingdingshan	0.412	27	0.500	17	10	Yuzhou	0.400	35	0.412	37	-2
Sanmenxia	0.415	25	0.493	18	7	Linfen	0.383	38	0.410	38	0
Jiaozuo	0.423	16	0.492	19	-3	Lvliang	0.370	40	0.401	39	1
Laiwu	0.420	22	0.484	20	2	Yangquan	0.390	37	0.398	40	-3
Hebei	0.539	-	0.662	-	-	Shandong	0.587	-	0.738	-	-
Shanxi	0.561	-	0.637	-	-	Henan	0.575	-	0.649	-	-
Anhui	0.535	-	0.631	-	-	Five provinces	0.559	-	0.664	-	-

Table 3: The annual growth rate of the sustainable development index of each city from 2009 to 2013 and from 2013 to 2017

City	Average annual growth rate of sustainable development index /%				Ranking change	City	Average annual growth rate of sustainable development index /%				Ranking change
	2009—2013	Ranking	2013—2017	Ranking			2009—2013	Ranking	2013—2017	Ranking	
Jinzhong	-3.961	40	11.631	1	39	Changzhi	0.011	36	2.444	21	15
Nanyang	1.037	27	7.712	2	25	Huainan	1.015	28	2.402	22	6
Ma’anshan	1.641	16	7.244	3	13	Chizhou	-2.984	38	2.350	23	15
Luoyang	0.857	30	6.542	4	26	Huaibei	2.223	12	2.227	24	-12
Suzhou	-0.896	37	5.706	5	32	Chengde	1.577	18	2.201	25	-7
Pingdingshan	2.010	14	4.991	6	8	Datong	1.111	26	2.103	26	0
Tangshan	1.607	17	4.674	7	10	Lvliang	0.923	29	2.038	27	2
Sanmenxia	2.191	13	4.427	8	5	Linfen	0.715	32	1.727	28	4
Zi’bo	4.889	3	4.399	9	-6	Yongcheng	1.497	22	1.640	29	-7
Linyi	0.244	35	4.256	10	25	Dongying	7.371	2	1.559	30	-28
Zaozhuang	1.140	25	3.987	11	14	Jincheng	1.428	23	1.544	31	-8
Jiaozuo	2.394	9	3.803	12	-3	Xingtai	-3.529	39	1.532	32	7
Puyang	3.460	4	3.604	13	-9	Shuozhou	1.301	24	1.372	33	-9
Chuzhou	2.240	11	3.589	14	-3	Yuzhou	0.464	33	0.744	34	-1
Laiwu	1.511	21	3.583	15	6	Yangquan	1.525	20	0.491	35	-15
Jining	0.842	31	3.465	16	15	Yizhou	2.720	6	0.386	36	-30
Taian	1.555	19	3.042	17	2	Yuncheng	3.320	5	0.293	37	-32
Zhangjiakou	1.837	15	2.938	18	-3	Handan	2.278	10	-0.147	38	-28
Hebi	2.665	7	2.932	19	-12	Xuancheng	2.465	8	-0.614	39	-31
Haozhou	0.438	34	2.772	20	14	Tonglin	8.286	1	-2.092	40	-39
Hebei	2.697	-	5.266	-	-	Shandong	3.186	-	5.918	-	-

Shanxi	3.839	-	3.228	-	-	Henan	2.872	-	3.089	-	-
Anhui	2.641	-	4.208	-	-	Five	3.049	-	4.362	-	-

It can be seen from Table 2 that the evaluation index of 34 cities is between 0.4-0.55, accounting for 85% of the total, and the distribution is relatively concentrated, indicating that the sustainable development capacity of most cities is relatively close. However, the highest ranking Dongying City is 1.68 times higher than the lowest ranking Yangquan City index, with a gap of 0.271, indicating that there are still great differences in sustainability between individual cities. Compared with the average value of each province, among the 40 cities in 2017, only Dongying City had the evaluation index exceeding the average value of the five provinces, and the rest were below the average value of the five provinces. According to the analysis of each province, only Jinzhong City in Shanxi Province has reached the provincial average value, and the evaluation indexes of resource cities in the other four provinces have not reached the provincial average value. It shows that the sustainable development ability of resource-based cities is still weak compared with other cities, and there is still a certain distance from the average level of each province.

As shown in Table 3, the average annual growth rate of Jinzhong City from 2013 to 2017 was the fastest, reaching 11.631%, far ahead of Nanyang and Ma'anshan. However, among the 40 cities, only 5 have an average annual growth rate of more than 5%, and 22 are between 2% and 5%. The improvement of urban sustainable development capacity is relatively slow. The average annual growth rate of Handan, Xuancheng and Tongling is negative. On the contrary, the city's sustainable development ability has not been enhanced, but also declined slightly. Compared with the average speed of each province, 9 of the 40 cities in 2013-2017 grew faster than the average of the five provinces. According to the analysis of each province, there are 4, 2 and 1 cities in Henan, Anhui and Shanxi respectively reaching the provincial average speed, while there are 0 cities in Hebei and Shandong. Compared with the evaluation index, the growth rate of sustainable development capacity of resource-based cities is better, nearly 20% of cities exceed the average development rate of the province, and most cities are close, indicating that resource-based cities are trying to change the current situation of insufficient sustainable development.

4.2. Difference analysis of influencing factors

Based on the existing quantitative data, this paper will not use the general theoretical analysis to study the influencing factors of sustainable development of resource-based cities, but analyze the contribution rate of sustainable development with five primary indicators. The greater the contribution rate, the greater the impact of the index on sustainable development. The contribution rate formula is as follows:

$$CR_{Xi} = \frac{W_{Xi} R_{Xi}}{R_{可持续}}$$

(i =1,2,3,4,5)

As shown in Table 4, on the whole, scientific and technological innovation has the greatest impact on the sustainable development of resource-based cities. Among the four types of resource cities, the contribution rate of scientific and technological innovation to sustainable development is more than 25%. It shows that in the process of promoting the sustainable development of resource-based cities, scientific and technological innovation is the key, and it is necessary to increase the support for scientific and technological innovation, seek development with innovation and seek the future with science and technology. Survival support has the least impact on sustainable development. Among the four types of resource cities, the contribution rate of survival support is between 10% and 13%. The changes of land, agriculture and population indicators in survival support are limited by endowment. It is

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difficult to promote the process of sustainable development from the perspective of survival support, but survival support is the basis of all development, although it can not make rapid progress, We also need to pay attention to it. The impact of the other three indicators on sustainable development is differentiated in the four types of cities.

In the growing resource cities, economic development, people's livelihood improvement and eco-environmental protection have similar impact on sustainable development, and eco-environmental protection is slightly higher, with a contribution of 22.9%; Among mature resource cities, the impact of livelihood improvement indicators on sustainable development is the lowest, with a contribution rate of only 16.5%, and the other two indicators are more than 20%; Among the declining resource cities, eco-environmental protection has the greatest impact on sustainable development, with a contribution rate of 24.4%, and the other two indicators are lower, both below 20%; In renewable resource cities, the impact of the three indicators on sustainable development returns to a similar state again, and their contribution rates are between 19% and 22%

Table 4: Contribution rate of 2017 primary indicators to sustainable development

City type	Contribution rate（%）				
	Economic development	Improvement of people's livelihood	Ecological environment protection	Survival support	Technological innovation
Growth type	20.4	19.1	22.9	12.6	25.0
Mature type	20.4	16.5	23.0	12.6	27.6
Recession	17.7	19.9	24.4	11.5	26.5
Regenerative	19.9	21.1	22.4	10.7	25.8

5. Result analysis

Starting from the analysis of the sustainable development capacity and influencing factors of various types of resource-based cities, and based on the construction of the comprehensive evaluation index system of the sustainable development capacity of resource-based cities, this paper quantifies the sustainable development capacity into the correlation evaluation index by using the entropy weight method and the grey comprehensive evaluation method, and makes a classified study on 40 resource-based cities. The conclusions are as follows:

(1) From the overall evaluation results, the sustainable development capacity of most cities has been enhanced, but there is still a decline in the sustainable development capacity of a few cities. At the same time, only a few cities have a sustainable development growth rate of more than 7%, and more than 50% of cities have a growth rate of between 2% and 5%, so the sustainable development rate is generally not fast. It can be seen that there are obvious differences in sustainable development capacity and growth rate among different cities.

Based on the analysis of the factors affecting the sustainable development ability of various resource-based cities, it can be concluded that: ① on the whole, scientific and technological innovation has the greatest impact on the sustainable development of resource-based cities and the least impact on survival support. ② The impact of economic development, improvement of people's livelihood and ecological and environmental protection on sustainable development is differentiated in four types of cities. In growth and regeneration cities, the impact of the three indicators is similar. Among mature cities, the impact of people's livelihood improvement is the

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lowest. Among the declining cities, the impact of ecological environment protection is the greatest.

Based on the above analysis results, in order to enhance the sustainable development capacity of resource-based cities and accelerate the regional coordinated development of the Central Plains Economic Zone, this paper puts forward the following suggestions according to the weak points in the process of sustainable development of various types of Resource-based Cities:

Strengthen the awareness of ecological environment protection in growing resource cities. We need to establish the concept of sustainable development, refuse to follow the old road of "pollution before treatment", establish a perfect environmental supervision mechanism at the early stage of resource development, strive to achieve the coordinated development of resource mining and environmental protection, adhere to the concept of green mining, achieve environmental protection, efficient and intensive mining, and close mines or factories with serious environmental pollution and backward technology, We should reduce the discharge of pollutants from the source.

Improve the quality of life of people in mature resource cities. While efficiently developing and utilizing resources, we should vigorously promote the improvement of people's livelihood. With the passing of the peak period of resource exploitation, some resource enterprises gradually withdraw, which is bound to produce unemployed people. Therefore, we should formulate a plan for the reemployment security system and improve people's living standards. We will strictly implement social security policies, earnestly ensure people's livelihood, improve urban infrastructure construction, and improve the level of urban public services.

Support declining resource cities to take over the development of industries. The environmental governance of declining resource cities has achieved remarkable results, but the sustainability of economic development is still lacking. Therefore, it is necessary to strengthen the adjustment of economic structure, change the mode of economic growth and cultivate a new economic growth pole. We can formulate appropriate financial assistance policies, attract innovative enterprises, make urban planning, create a good environment suitable for the development of new industries, formulate talent introduction plans, and support economic transformation and development.

Promote the diversified development of renewable resource cities. The sustainable development of renewable resource cities has made great progress in many aspects, but it needs to be improved in the field of scientific and technological innovation. Therefore, on the basis of further optimizing the quality of economic development, accelerating the construction of modern urban services, strengthening ecological and environmental protection and improving the basic functions of the city,

We should promote talent innovation, technological innovation and industrial innovation, promote the sustainable development of urban scientific and technological innovation, and form a number of diversified development cities with economy, people's livelihood, environment and innovation as the core.

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